UNDERSTANDING EXTREME SPORTS: A PSYCHOLOGICAL PERSPECTIVE

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UNDERSTANDING EXTREME SPORTS: A PSYCHOLOGICAL PERSPECTIVE

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Extreme sports, those activities that lie on the outermost edges of independent adventurous leisure activities, where a mismanaged mistake or accident would most likely result in death, have developed into a significant worldwide phenomenon (Brymer & Schweitzer, 2017a). Extreme sport activities are continually evolving, typical examples include BASE (an acronym for Buildings, Antennae, Span, Earth) jumping and related activities such as proximity flying, extreme skiing, big wave surfing, waterfall kayaking, rope free solo climbing and high-level mountaineering. While participant numbers in many traditional team and individual sports such as golf, basketball and racket sports have declined over the last decade or so, participant numbers in so called extreme sports have surged. Although extreme sports are still assumed to be a Western pastime, there has been considerable Global uptake. Equally, the idea that adventure sports are only for the young is also changing as participation rates across the generations are growing. For example, baby boomers are enthusiastic participants of adventure sports more generally (Brymer & Schweitzer, 2017b; Patterson, 2002) and Generation Z turn to extreme sports because they are popular and linked to escapism (Giannoulakis & Pursglove, 2017). Arguably, extreme sports now support a multi-billion dollar industry and the momentum seems to be intensifying.

Traditional explanations for why extreme sports have become so popular are varied. For some, the popularity is explained as the desire to rebel against a society that is becoming too risk averse, for others it is about the spectacle and the merchandise that is associated with organised activities and athletes. For others it is just that there are a lot of people attracted by risk and danger or just want to show off. For others still it is about the desire to belong to sub-cultures and the glamour that goes with extreme sports. Some seek mastery in their chosen activity and in situations of significant challenges. This confusion is unfortunate as despite their popularity there is still a negative perception about extreme sports participation. There is a pressing need for clarity. The dominant research perspective has focused on positivist theory-driven perspectives that attempt to match extreme sports against predetermined characteristics. For the most part empirical research has conformed to predetermined societal perspectives. Other ways of knowing might reveal more nuanced perspectives of the human dimension of extreme sport participation. This special edition brings together cutting-edge research and thought examining psychology and extreme sports, with particular attention payed to the examination of motivations for initial participation, continued participation, effective performance, and outcomes from participation.

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EDITORIAL
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Editorial: Understanding Extreme Sports: A Psychological Perspective

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Editorial on the Research Topic

Understanding Extreme Sports: A Psychological Perspective

A new class of sport has emerged in the last few decades, variously called extreme, adventure, action, and lifestyle sports. These activities are revolutionizing the notion of sport, exercise and physical activity and overtaking many traditional sports in terms of participation, and influence. They have developed into a significant worldwide phenomenon with considerable social and economic impact (Brymer and Schweitzer, 2017a). While participant numbers in many traditional team and individual sports such as golf, basketball, and racket sports have declined over the last decade or so, participant numbers in so-called extreme sports have surged. The current trajectory suggests that traditional sports will soon play second fiddle to these new and exciting opportunities. With the continually rising participation rates in these activities, science and medicine is starting to give these sports the same attention already given to traditional sports (Feletti et al., 2017). However, this attention needs to consider the unique and nuanced characteristics of the people involved, their motivation, and the activities. As already noted and further highlighted by many articles in this special edition, extreme sports are not well-served by approaches that stem from traditional sports research (Arijs et al.).

From a psychological viewpoint, while the tendency has been to assume that the activities and experiences described as extreme sports are somehow homogenous, research is questioning these assumptions and revealing important nuances between activities and subdisciplines within the same activity (Collins and Brymer, 2018). These nuances are pointing to understandings that not only help explore extreme sports more generally but also revealing important information about what it means to be human (Brymer and Schweitzer, 2017b).

Traditional explanations for why extreme sports have become so popular are varied but for the most part stem from a notion that extreme sport participation is deviant or undesirable. Indeed, there are many examples of the downside of extreme sports. For example, Everest and other high and popular mountains have long been associated with the rubbish left over by mountaineers (Bishop and Naumann, 1996) and with notorious images of mountaineers walking past dying colleagues (Elmes and Barry, 1999). This special edition does not set out to refute these happenings, rather add to the work already undertaken.

Traditional notions on motivations include perspectives that stress rebellion against a society that is becoming too risk-averse. For others, it is about the spectacle and the merchandise that is associated with organized activities and glamorous athletes. Authors have also proposed that extreme sport participation is merely an outlet for those people attracted by risk and danger or the desire to brag. For others still, it is about the desire to belong to sub-cultures and the glamor that goes with extreme sports. This confusing array of explanations is unfortunate as despite their popularity there are still negative perceptions about extreme sports participation particularly acute immediately after accidents or adverse incidents.

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Attempts to categorize extreme sport activities have been challenging but as authors in this special edition attest (see Immonen et al.; Cohen et al. in this edition) we are rapidly moving into an age where the nuances make a considerable difference when we investigate motivations, performance and outcomes, and as such clarity is fast becoming essential. Traditional attempts to define extreme sports have variously focused on either task elements, environmental characteristics or individual participants, separately, or in combination. From a task perspective, the traditional emphasis has been on the activity being high-risk or dangerous with the potential to cause considerable harm or even death of the participant. More recently, the risk notion has been downplayed, and extreme sport activities have been differentiated from mainstream sports because extreme sports are typically not governed by external rules and regulations. In this special edition, activities have been described as both competitive (see Cohen et al.) or non-competitive and creative (see Immonen et al.; Cohen et al.).

The traditional participant perspective has generally accepted that participants are outliers (at times deviant), emphasizing personality, emotional impact, and the role of adrenaline and thrill. Participants are assumed to search out opportunities for participation because they have underlying personality structures that demand novel, risky, and dangerous experiences. The environment perspective has leant on both social and physical explanations. Those studies espousing the social environment most often write about the impact of social pressure on performance or how extreme sports are an invention stemming from sub-cultural desires to rebel against mainstream society or demonstrate perceived masculine characteristics. Those studies focusing on the physical environment tend to project the environment as key to understanding extreme sport participation and focus on the natural world as dynamic, unconstrained by human intervention, or dangerous and needing to be tamed or controlled. The traditional approach has suggested that participants compete against the environment. However, research has critiqued this perspective, pointing out that participants recognize competition with the environment would be fruitless. More recent research has differentiated extreme sport participation from traditional sport participation because the environment is not constrained by artificial boundaries (Feletti and Brymer, 2018).

Part of the confusion seems to be that extreme sports activities are continually evolving, partially facilitated by technology and partially by the creative capacities and skills of participants. For example, extreme activities such as BASE (an acronym for Buildings, Antennae, Span, Earth) jumping has evolved to include proximity flying. Tow-in surfing, developed in the 90s and facilitated the capacity to ride bigger waves. Equally, although extreme sports are still assumed to be a Western pastime, there has been considerable uptake across the globe (Brymer and Schweitzer, 2017a). The idea that extreme sports are only for the young is also changing as participation rates across generations are growing. Baby boomers are enthusiastic participants of a variety of adventurous sports more generally. The gender divide is another presupposition that is being questioned (see Frühauf et al.; Monasterio et al. in this edition). Extreme sports now support a multi-billion dollar industry, and the momentum seems to be intensifying. Interestingly, as noted above, this has also opened up opportunities for versions of extreme sports to be included in mainstream events such as the Olympic Games. For example, kitesurfing made its first appearance at the 2018 Youth Olympic Games in Buenos Aires, Argentina and will be included in the 2024 Paris Olympic Games. Surfing, rock climbing and skateboarding will also be making their debut at the 2020 Olympic Games in Tokyo, Japan. Media and the general public have been captivated by images of high velocity, high altitude, forceful accelerations, and extreme physical precision required to perform these sports. In turn, these developments have has added to the confusion about the importance of competition.

There is a pressing need for clarity. The dominant research perspective has focused on positivist theory-driven perspectives that attempt to match participation in extreme sports against predetermined characteristics. For the most part, empirical research has conformed to predetermined societal perspectives. Other ways of knowing have revealed more nuanced perspectives of the human dimension of extreme sport participation. There has been considerable development of research into extreme sports since the early days in the 1960s. Studies focusing on medicine, sociology, physiology, and psychology are now being published in mainstream outlets, and extreme sports research has become a visible part of many traditional research agendas. While, researchers are still working to understand the experience better map out how best to support learning and document the outcomes from extreme sport participation, researchers also realize that extreme sports have a lot to offer research in mainstream sports and findings from extreme sports research are proving pertinent to our understanding of everyday experiences.

The **impact of extreme sports on health and well-being** represents one of the most interesting themes to emerge from the extreme sport experience reported in this special edition and supported by contemporary research. Research in this special edition indicates that, if managed effectively (Schüler et al.; Buckley, in this edition), participation in extreme sports can induce positive emotions and resilience, and facilitate the development of skills and physical capacities that support flourishing in everyday life (see Maclntyre et al. and Hetland et al.). Maclntyre et al., highlight findings that support the idea that extreme sport participation can lead to positive relationships with the natural world and pro-environmental behaviors (Brymer et al., 2009; Brymer and Gray, 2010). Extreme sports are described as meaningful and life-enhancing (see Immonen et al.) with the potential to be used as therapeutic interventions to address everyday psychological issues and drug abuse (see Roberts et al.; Roderique-Davies et al.). Holmbom et al., argue that extreme sport participation is very different from traditional sports perhaps because the potential outcome is far more serious. They argue that extreme sports have profound positive transformational capacities and that the skills learnt during extreme sports were relevant for, and enhanced everyday life.

Another interesting theme to emerge from this special edition, and highlighted in the current discourse on extreme sports, concerns **how extreme sports should be defined**. Risk does

not turn out to be as central a notion as has traditionally been assumed. Buckley points to a definition that combines person and task elements of participation. Extreme sports are placed further along a continuum from adventure sports where death is a potential; survival relies on "moment to moment skill" and emotions involved in thrill are the central notions. Cohen et al. propose extreme sports should be defined by the type of activity. They suggest that extreme sports are by nature competitive activities undertaken in natural contexts with atypical physical challenges and the potential of death as an outcome. On the contrary, Langseth and Salvesen focuses on the role of values and Immonen et al. argue for a more creative and meaning based definition where extreme sports and traditional sports differ precisely because competition is not emphasized in extreme sports. Attention is given to aesthetic criteria rather than traditional quantitative parameters (e.g., distance, time, score) when assessing performance. Like Buckley, Cohen et al. argues that risk is what differentiates extreme from traditional sports. However, as above the importance of risk is questioned by Immonen et al. who point out that the risk focus has important limitations and provide a more relational appreciation of extreme sports as emergent activities that afford opportunities for existential reflection and self-actualization. Again, they emphasize the relationship between performer and environment to argue their case.

The third outcome of this special edition links to **learning and performance in extreme sports**. First, the idea that only certain people undertake extreme sports, usually determined by the personality characteristics of the participant or underpinned by gender or the adrenaline junky explanation might not stand up to scrutiny (Collins et al.). Research reported in this special edition suggests that individual participant characteristics are broad and not easily captured by personality measures or gender (Monasterio et al.; Frühauf et al.). Second, in contrast to more traditional perspectives that assume skilled performance relies on innate individual characteristics, articles in this special edition point to other mechanisms. Arijs et al., argue that performance in extreme sports is very different from performance in traditional sports because of the seriousness and potential consequences of the activity. Instead of a traditional narrative that emphasizes winning, extreme sports accentuate exploration, discovery and a relational perspective linking profound knowledge of self and task and attunement to information in the environment as key to effective performance. Seifert et al. (this edition), in their skill acquisition focus, support a relational perspective, arguing that learning and performance are linked to a productive person-environment relationship and the development of more effective attunement to affordances (invitations for action) in the environment. Learning in extreme sports is about how well the performer perceives opportunities for action that combine personal characteristics with environmental characteristics. Collins et al. follow a skills training model demonstrating the ways in which knowledge of performance in emerging competitive versions of extreme sports extends traditional sporting models. Developing skills and expertise to perform effectively in extreme sports also facilitates opportunities to rethink learning in other sports, and more generally across learning environments.

Motives and motivations for participation in extreme sports emerged as a fourth theme in this special edition. The majority of articles in this edition have questioned the assumption that a particular type of person participates in extreme sports or that the desire for risk and danger underpinned participation. McEwan et al. (this edition) point out that traditional assumptions that emphasize homogeneity in extreme sport participation might be limited. Instead, they draw attention to differences in motivations and interests even within the same sport, in their case, mountain biking. Monasterio and Cloninger (this edition) examined personality structures of BASE jumpers and mountaineers; they determined that while personality measures did not suggest that extreme sports athletes were a homogenous group, there were trends toward being controlled and adventurous. Men and women shared similar characteristics and constructs such as self-actualization were more critical in understanding the motivation of extreme sports people compared to the traditional notion of social pressure. Happiness, challenging oneself, being in nature, friendships, and balance were also noted as important factors (Hetland et al.; Frühauf et al.).

The themes highlighted above suggest four interesting take-home messages from this special edition:

1. Engaging in extreme sports and adventure more generally provides us with important insights into what it means to be human. From a practice and policy perspective, the scholarly study of extreme sport participation suggests that we should be finding ways to encourage participation across the lifespan and finding ways to include extreme sports and adventure in activities designed to enhance health, education and physical activity participation. While traditional perspectives on the reason for encouraging adventure may no longer be relevant, the impacts of participation in adventure are more essential today than ever before.
2. Extreme sports are complex. Looking for simple answers that emphasise aspects such as risk, personality, or social forces misses the point entirely. Perhaps more than any other type of human experience extreme sports provide a means to rethink the human-environment relationship and the importance of activities that do not focus on winning, rules, regulations, and manicured playgrounds. Extreme sports research should be encouraged across multiple disciplines.
3. Extreme sports participation is more likely to be suitable for the general population than not. Indeed, participation in extreme sports and their less extreme cousins support physical, social and psychological health and well-being across the lifespan and, notably, also the well-being of the planet. While there are challenges when it comes to the development of technology that supports advancements, in general, extreme sports should be encouraged, and should be considered significant positive activities worthy of consideration in policy development across the health, education, sport, and environment sectors. Extreme sports should be considered a fruitful approach for involving people

in health-enhancing and active lifestyles. Young people, in particular, should be encouraged to take part in these activities to foster social interaction, informal learning, and socio-cultural integration.
4. Intriguingly, research reported in this special edition points to knowledge gained in extreme sports as useful for performance in other domains of life, such as business or sport.

In conclusion, extreme sports should not be considered activities for the few but fundamental aspects of human expression and the development of healthy populations and environments.

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All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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Transformations through Proximity Flying: A Phenomenological Investigation

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Participation in extreme sports has been linked to personal transformations in everyday life. Descriptions of lived experience resulting from transformative experiences are limited. Proximity flying, a relatively new discipline involving BASE jumping with a wingsuit where participants fly close to solid structures, is arguably one of the most extreme of extreme sports. The aim of this paper, part of a larger phenomenological study on the lived experience of proximity flying, is to explicate the ways in which participating in proximity flying influences the everyday lives of participants. Interpretative phenomenological analysis was used to explicate the lived experience of six proximity pilots. An analysis of interview transcripts revealed three significant themes describing the lived experience of participants. First, experiences of change were described as positive and skills developed through proximity flying were transferable into everyday life. Second, transformative experiences were considered fundamental to participants' perspectives on life. Third, experience of transformation influenced their sense of personal identity and facilitated flourishing in other aspects of everyday life. Participants were clear that their experiences in proximity flying facilitated a profound process of transformation which manifest as changes in everyday capabilities and behaviors, values and sense of identity.

Keywords: extreme sports, proximity flying, personal transformation, phenomenology, well-being, identity

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INTRODUCTION

Over the last 40 years research on extreme sport participants has focused on providing explanations for participants engaging in a leisure activity, where death is the most likely consequence of a mismanaged mistake or accident (Brymer and Schweitzer, 2017). The dominant, theory-driven perspective on extreme sport participation focusses upon understanding personality and motivations placing extreme sport athletes in a similar category to illicit drug takers and deviant social groups. That is, there is an argument that motivation for engaging in such activities stems from deep seated personality deficits that manifest as a basic, pathological need for thrills and risk (e.g., Zuckerman, 1994; Elmes and Barry, 1999; Franques et al., 2003; Pain and Pain, 2005; Self et al., 2007). From this perspective, extreme sport participants are typically considered selfish, young males 'fascinated with the individuality, risk, and danger of the sports' (Bennett et al., 2003, p. 98). Extreme sport participation is most often explained as the need for an adrenaline rush or because participants are just plain crazy trying to prove themselves worthy of respect by fighting nature or taking unnecessary risks (Le Breton, 2000; Monasterio, 2007).

The traditional risk focus that presupposes that extreme sports are about undesirable risk taking is being questioned as more recent studies in personality and psychology report that while risk and deviancy might explain the motives of some participants, the variance is too great to be useful to describe a participant population more generally (Woodman et al., 2010; Kerr and Houge Mackenzie, 2012; Monasterio et al., 2014). Furthermore, there is an emerging body of research, often drawing upon phenomenology, challenging traditional assumptions, and presenting more nuanced perspectives on motivations for participation in extreme sports (Willig, 2008; Brymer and Gray, 2009; Brymer and Oades, 2009; Brymer et al., 2009; Kerr and Houge Mackenzie, 2012; Brymer and Schweitzer, 2013, 2014; Simpson et al., 2014; Wiersma, 2014). Results from these studies suggest that while risk and thrills might underlie initial motivations for some participants, risk-seeking is not reflected in the deliberations of more experienced athletes who invariably refute these assertions (Celsi et al., 1993; Willig, 2008; Brymer and Oades, 2009; Kerr and Houge Mackenzie, 2012). Experienced extreme sport athletes are more likely to associate participation with positive and life enhancing experiences, either because the act itself (e.g., catching and surfing a big wave) is meaningful or due to the fact that the extreme sport experience is itself transformational (Brymer, 2013). While a number of studies have documented the experience of participation, the transformational hypothesis is less well developed (Brymer, 2013). In this paper, we present results from a larger phenomenological study with six highly experienced extreme sport athletes who engage in proximity flying, outlining their everyday lived experience which they report has been transformed as a result of proximity flying.

Transformations through Extreme Sports

In recent years, research has indicated that extreme sports are associated with positive life enhancing change. Researchers point to the potential for extreme sports to transform everyday lived experience (Willig, 2008). However, descriptions of the outcomes of being transformed are limited. Extreme sports have been promoted as a medium for learning about goal achievement and mastery (Willig, 2008; Allman et al., 2009; Kerr and Houge Mackenzie, 2012), overcoming and managing fear and anxiety (Allman et al., 2009; Kerr and Houge Mackenzie, 2012; Brymer and Schweitzer, 2013), developing self-efficacy (Slanger and Rudestam, 1997), and increasing self-esteem (Willig, 2008). These attributes have the potential to enhance participants' sense of self, and quality of life.

Extreme sports have also been associated with the development of a new sense of identity (Celsi et al., 1993; Maeland, 2002, unpublished; Larkin and Griffiths, 2004; Allman et al., 2009; Brymer and Oades, 2009). For example, Brymer (2013) argued that extreme sports facilitated 'an inner journey to self-discovery and an opportunity for reflecting on personal capabilities' (p. 115). Participation in extreme sports has been posited as providing opportunities to transcend limited ideas of 'self' and discovering a newly found and fulfilling sense of identity coupled with corresponding capabilities (Willig, 2008). However, neither Willig (2008) nor Brymer (2013) documented in what ways this might manifest in everyday life. Brymer and Schweitzer (2013) argued that the experience of fear inherent in extreme sports is embraced by athletes and used positively not just in order to ensure effective participation but also for overall psychological health and wellbeing. There was no attempt to describe the lived experience of extreme sport participants' renewed sense of wellbeing. Despite the lack of evidence or descriptions on how everyday life is lived, the notion that extreme sports transform everyday life in profound and positive ways has attracted some research attention (Willig, 2008; Allman et al., 2009; Brymer and Oades, 2009; Simpson et al., 2014). For some researchers, the notion has prompted claims that athletes consciously and deliberately utilize extreme sports in order to experience positive transformation (Allman et al., 2009). This article, part of a larger phenomenological study on proximity flying, articulates the everyday lived experience of pilots who engage in proximity flying. Findings indicate a direct link between participation in extreme sports and changes in the ways that everyday life is lived thus providing a tantalizing glimpse into how extreme sports might positively influence the everyday lives of participants.

Proximity Flying

Proximity flying is one of the most extreme of extreme sports, and arguably unique in guiding the pilot within a space between exhilaration and death, like no other sport experience. Proximity flying is a relatively new addition to BASE jumping (Mei-Dan et al., 2013). BASE is an acronym that stands for the four most common categories of objects from which an individual may jump: building, antenna, span, and earth (cliffs). The participants in proximity flying wear an inflatable ram-air wing design suit, called a wingsuit, which adds surface area to the body and allows forward motion. The airfoil design means that the pilots can glide horizontally for approximately 2–2.5 m for every meter they fall vertically (Berry et al., 2010). Like traditional BASE jumping, proximity pilots jump from solid, usually natural structures such as cliffs and mountains. Take off, otherwise known as launching, where the participant launches from the solid structure into space, is crucial in proximity flying since the participant needs to achieve particular body orientation for flight in a context of limited speed and maneuverability (Mei-Dan et al., 2013).

In the early days of BASE jumping with a wingsuit, the wingsuit design was smaller and pilots flew away from the cliffs to achieve a safe distance. The improved technology and the increased glide ratio of more modern designs allows 'flying' in close proximity to the ground, trees, and ridges either in brief flybys or extended terrain flying (Mei-Dan et al., 2013). This evolution in wingsuit BASE jumping is called proximity flying. Proximity pilots, like traditional BASE jumpers, use only one parachute compared to skydivers' two, and the parachute is deployed closer to the ground than in skydiving, often less than 150 m (altitude 500 ft) (Westman et al., 2008). Mei-Dan et al. (2013) reported that in 2013, approximately 90% of the deaths in BASE jumping were related to the use of wingsuits. The most common fatal mistake in proximity flying is glide path miscalculation and/or limited experience, resulting in cliff

or ground impact (Mei-Dan et al., 2013). Proximity flyers are thus encouraged to undertake rigorous training in BASE jumping and wingsuit skydiving, with a suggested minimum of 500 BASE jumps and to continuously practice emergency procedures on the ground, all as prerequisite to flying. Skydiving is a common training arena for wingsuit flying techniques as launching from airplanes means the pilot can avoid physical obstacles inherent in proximity flying.

Confronting Death, Transformation, and Authenticity

Theoretical perspectives from existential psychology suggest that accepting personal vulnerabilities, facing death, and experiencing the potential reality of our own death leads to a process of transformation encompassing fundamental values in the ways in which we experience our sense of self. Change in this context is understood in terms of a process of transformation resulting in a life lived more fully and with greater authenticity. The term transformation is seen as particularly apt, in that it is derived from the Latin, *transformatio*, referring to "change of shape." The shape of one's life is thus changed in that the experience leads to a life lived fully and authentically, where authenticity is understood as taking responsibility for one's own existence rather than following the crowd even though this might create discomfort (May, 1983). Being authentic is not an isolated end point but experienced as a process of becoming more true to oneself and accepting limitations and possibilities.

Rogers (1961) expressed this concept in terms of living one's life according to the needs of one's inner being, rather than the demands of society or early conditioning. Values and identities are not constructed from scratch but particular events or activities allow us to focus on the reality of our own finitude and facilitate a realization of our potential and our sense of who we are (Park, 2006). Life takes on a new, profound and positive meaning (Wong, 1998, 2000; Emmons, 1999). The end result of confronting and accepting the reality of our own death without self-importance is that both the sense of who we are, and our relationship with others are enhanced (Wong, 2000). From an existential perspective recognizing physical limitations, such as the temporary nature of physical security, through accepting the reality of our own death releases a capacity to live a full and meaningful life.

Heidegger recognized this notion as a paradox, where an experiential acceptance of the reality of our own death reveals the extent to which we have developed protective circumventions in our own life in order to protect ourselves against the challenge of living authentically. Revealing these protective strategies can facilitate a process of becoming more free, integrated, focused and centered, and thereby support learning to live more authentic lives (Zimmerman, 1986, p. 292). Extreme sports, providing participants have the appropriate personal characteristics (e.g., resiliency, optimism, and hardiness), can be described as extraordinary events that seem to facilitate increasing self-awareness leading to experiences of transformation in the way a participant lives her or his everyday life (Brymer and Oades, 2009; Brymer, 2013).

The notion of transformation as articulated above is reflected in both the literature on transformative learning and in reference to eudaimonia. Transformative learning is conceptualized as "processes that result in significant and irreversible changes in the way a person experiences, conceptualizes, and interacts with the world" (Hoggan, 2016, p. 71). Learning can happen instantaneously and manifests as profound shifts in consciousness and the ways in which we understand ourselves, the natural world, and others (Brymer, 2013). Eudaimonia has its origin in Greek, with "*eu*" (good) and "*daimon*" ("spirit"). The term thus refers to the realization of one's potential, and calls upon us to fulfill our destiny by recognizing and living with one's daimon, or "true self" (Norton, 1976). Eudaimonia may thus refer to the feelings available when one is moving toward self-realization and furthering one's purpose in living through activity. Certain events, such as those that bring us closer to realizing and accepting the inevitability of our own death, provide a medium for momentous realizations which 'energizes us to live with vitality and purpose' (Wong, 2008, p. 69). This realization of a deeper sense of potential facilitates a clearer appreciation of personal needs, wants and desires (Wong, 2008). According to Wong and Tomer (2011) a positive acceptance of the reality of our own death, as outlined by meaning management theory (MMT) rather than the management of terror assumed to be linked to experiences of death, predicts a life lived by 'maximizing meaning, fulfillment and joy' (Wong and Tomer, 2011, p. 104). That is, the transformations experienced in these instances are life enhancing and result from being connected to, or more in tune with a deeper sense of self which has been hidden from the person's view 'by socio-cultural noise and interference; noise that dictates who we 'should' be and how we 'should' lead life' (Brymer, 2013, p. 6). Arguably, the extreme sport experience acts as a facilitator that removes barriers to noticing the noise and interference and presents an opportunity for an individual to hear their authentic 'own-self.' In Heideggerian terms 'in order to gain everything, one must give up everything' (Zimmerman, 1986, p. 292).

MATERIALS AND METHODS

Qualitative methodologies allow for the rich description of novel human experiences, with particular salience in exploring the lived experience of participants. The current study draws from a larger phenomenological study seeking to explicate the experiences of elite wingsuit pilots' engaging in proximity flying. Ethical approval for the larger study was in line with the requirements of the University of the first author. Interpretive Phenomenological Analysis (IPA) provides both an inductive and systematized qualitative methodology to address the aims of the study.

Interpretive Phenomenological Analysis draws on key features from phenomenology, hermeneutics, and ideography. Within the field of psychology, phenomenology focuses upon phenomena as experienced. Phenomenology draws upon the philosophical principles originally developed by Husserl (1859–1938) who wished to find an absolute basis for knowing or knowledge. Husserl challenged what has come to be called "scientism" and

sought to return to fundamental human experience, which he believed may be understood in terms of intentionality (Brymer and Schweitzer, 2017). From this perspective, the researcher attempts to capture the nature, the quality, and the meaning of participant experience. To understand the lived experience of phenomena, the researcher adopts a phenomenological paradigm. In contrast to the dominant natural science paradigm which privileges objectivity phenomenology seeks to gain understanding by processing data in an iterative manner referred to as a hermeneutic circle. That is, a methodological process of understanding the whole by reference to the parts, and at the same time, understanding parts by reference to the whole. Hermeneutics is more commonly applied to the understanding of texts, but may also play a role in a psychological methodology where the aim is to understand human experience and the meanings attributed to experience (Willig, 2013). IPA draws upon in-depth accounts produced by participants, for example diary notes or transcribed interview data (Willig, 2013). In the larger study, in-depth interviews were used to reveal participants' ways of understanding their personal experience of proximity flying. IPA is idiographic through encouraging an in-depth study of individual cases, focusing on particular individuals, but also nomothetic, as the findings are integrated and represent the experience of the group (Smith et al., 2009).

Crucial in phenomenology is for the researcher to become aware of personal presuppositions and assumptions about phenomena and consciously put them aside, which is referred to as bracketing, with a view to being open to the phenomenon as it presents itself in all its particularity. As part of the process of bracketing the first author created a mind-map representing personal and theoretical presuppositions before conducting the study in order to make assumptions explicit and facilitate reflections on potential bias in interviewing and explicating the data. The mind-map was continually referred to and updated. In the initial stages this process facilitated self-reflection about undertaking the study and the development of appropriate questions. The mind-map which operationalized the process of bracketing was used as a personal tool throughout the writing process to remind the researchers of possible bias. This resulted in a strong awareness of values, perceptions, expectations and feelings about extreme sports and proximity flying, e.g., that the wingsuit pilots mostly are intrinsically motivated. The second and third author also carried out a reflexive process which made explicit their own biases as part of the data analysis dialog. In the following sections, we outline how the study was undertaken.

Participants

Participants were recruited by the first author following purposive sampling. To be included in the project pilots needed to be highly experienced in proximity flying and willing to explore the proximity flying experience. Participants also needed to be able to communicate their experience in English or in Swedish. Twenty-seven (25 males and 2 females) proximity pilots who competed in either the 2013 World Wingsuit League in the Tianmen Mountains, China, or the 2013 HeliBASE 74, in Switzerland were initially contacted. Two male pilots experienced fatal accidents while proximity flying in 2013. Eight pilots who met the criteria accepted the invitation and six male proximity wingsuit pilots eventually participated in the study. Two pilots were unable to meet for interviews either online or in person. Participants were over 30 years of age and heralded from Europe, Australasia, and the Americas. Five of the participants were married; one had children. All participants were either sponsored or professional extreme sport athletes.

Interviews

Following the provision of informed consent, interviews were conducted by the first author using a semi-structured approach through online video conversations. Interviews were recorded for later transcription. The first interview was conducted in Swedish and the following five interviews were conducted in English. All interviews were guided by the research question 'what is your experience of proximity flying'? Specifically, pilots were asked; (1) *Please share your stories about how you discovered proximity flying* and (2) *Please describe a particular proximity flight with as much detail as possible*. In order to facilitate deep reflection and enhance the potential of rich description these two questions were sent by e-mail to participants prior to the interviews. To gain a more in-depth understanding of the experience of proximity flying, the interviewer followed up with contextualized prompts, such as: 'Please tell me more' or 'please could you expand'? Emphasis was placed upon specific experiences with the intention of eliciting states of mind, otherwise understood as lived experience as opposed to a chronicle of events. In keeping with the principles of phenomenology, the aim was to elicit a detailed and penetrating description of the experience, with a focus on the meaning and significance of the experience.

Data Analysis

The interviews were transcribed verbatim and pseudonyms were allocated to each interview transcript to safeguard confidentiality. In the first stage of analysis, the first author listened to each transcript followed by transcribing the audiotape. This was followed by a process of reading and re-reading the transcripts to gain a sense of the data as a whole, focusing upon the participant's perspective and experiences. In this sense, the investigator continued to adopt a phenomenological stance, in that assumptions were "bracketed," allowing the data, as far as was possible, to speak for itself. The phenomenological attitude also requires a particular stance based upon an understanding of intentionality. That is, an appreciation that consciousness is not based upon the dominant paradigm of a subject–object view of events, but as consciousness and the object of consciousness, in this instance, the experience of proximity flying, being co-constituted (Brymer and Schweitzer, 2017). Adopting this attitude, the developed texts were shared with the second and third authors in order to facilitate future dialog and the development of the thematic structures.

The second stage involved the first author making initial notes on each transcript focusing on descriptive, linguistic, and conceptual comments which were used to underpin the emerging themes. Descriptive comments were then used to initiate the development of phenomenological themes. Linguistic comments explored the participants' use of language, for example 'unable

to explain the feeling in words,' or 'emphasizing importance by swearing,' while conceptual comments focused on a more theoretical and questioning form, such as 'transference of lessons learned' or 'a fundamental change?' Conceptual comments emerging from this process were guided by participants' reported experience. This stage of analysis was repeated several times for each interview.

The third stage of analysis comprised identifying and labeling emerging themes, focusing on the nature, quality and meaning of participants' experiences of proximity flying. This stage involved staying close to the participants' lived-experience. The emerging themes were coded with terms such as 'transferring skills to everyday life,' 'positive mood change,' 'life-changing experience,' and 'new-found values in life.' The process of explication was repeated for each transcript. The second and third author provided feedback and facilitated a process whereby emerging constructs were interrogated in terms of their relevance, cross over or connection with other themes.

The fourth stage involved themes being clustered to better portray the finer distinctions expressed by participants. In the fifth stage, the clusters of themes were abstracted into overarching themes. This process was guided by reflective questions: 'How is this relevant to the phenomenology of proximity flying?', 'What is the nature, quality, and meaning in this account?' (Wiersma, 2014), and 'What may we be missing?' All authors contributed to stages four and five, and arrived at a consensus for the development of and explication of the final themes constituting the phenomenon. Themes were referred to participants for comments and checking that they were consistent with the respondents' lived-experience. Responses received affirmed that the findings reflected participants' lived experience.

RESULTS

This article focuses on one important dimension of proximity pilots' experience, that is, the lived-experience of transformation gained through the extreme sport of proximity flying. The notion of transformation is distinguished from a natural science perspective, of changes conceived as a measured state of difference between before and after, but refers to the recalled experience of participants, and is better understood in terms of lived-experience of how the change is manifest in the everyday consciousness of participants, from the Latin *transformatio*, which refers to "change in shape or metamorphose." The experiences described by participants reflect the experience of change or "metamorphosis" which is experienced in terms of the discovering of capabilities, values, and the realization of a sense of identity that may have been available to the participant but was, in a phenomenological sense, previously hidden from view.

Three themes emerged from the data revealing changes in everyday capabilities, behaviors, values, and sense of identity (see **Table 1**). Participants clearly recognized and gave voice to the experience of change and that these changes were directly associated with their experience of participating in proximity flying. First, participants reported that these experiences were positive and experienced as manifest in the ways that everyday life was lived. Second, these transformative experiences were considered to be fundamental to participant perspectives on life. Third, these changes, termed transformations influenced their sense of personal identity and facilitated flourishing in other aspects of everyday life. In the following sections we explicate the three overarching themes that emerged as describing the ways in which participation in proximity flying transformed everyday live experience: transferability of capabilities, life as meaningful, and emergence of selfhood. Each of these overarching themes were regarded as aspects of transformation. In order to properly associate these experiences with proximity flying we begin by reporting on the connections made by proximity flyers between participation in their sport and the experience of transformation.

Participants were unanimous that participation in proximity flying had transformed them in profound and positive ways. For example, Adam determined that proximity flying profoundly added to his everyday life experiences.

> It means so much more to me than the flight in itself. It defines me as a human being, it gives me confidence in many other places in society. It makes me happier, it gives me a lot more energy. It makes me feel that no other challenge is too big. It has such a synergic effect on me as a human being that means incredibly much to me. (Adam)

Here, Adam describes flying as a defining concept that provides a foundation for many positive transformations such as increased confidence, happiness, enhanced energy, and a realization that challenges are never too big to resolve. Eric also described how proximity flying changed him for the better:

> When you talk to people who knew me before and know me now, and they're like: "Dude!" And then you realize that my life has changed . . . That I am so happy and so complete. That I am more of a centered person, an inspirational person. The sport has brought the best out of me. (Eric)

In the quote above Eric describes how proximity flying was responsible for positive changes in the way he experiences everyday life manifest not just as increased happiness but as a sense of completeness not felt before taking up proximity flying. Participation in proximity flying has facilitated new ways of experiencing life and being in the world.

> Once I met this sport, I found an outlet, somewhere to let go of all of my energy. And everything made sense, you know,

TABLE 1 | The clusters of themes and identification of the overarching themes associated with the experience of having been transformed though proximity flying.

Clusters of themes	Overarching themes
Fear management, self-awareness, understanding of others, and the lived world	Transferability of capabilities
Acceptance of mortality facilitates a new perspective on life, embracing life, mindful appreciation	Life as meaningful
Unique identity, breaking free from constraints, authenticity	Emergence of selfhood

in life . . . Some of the things that I used to hold value to in the past, were not important anymore. (Eric)

This notion that proximity flying is responsible for enabling a pilot to tune into fundamental values is recognized by others. For some such as Eric above it is described as an experience of completion and for others about instigating profound self-knowledge. For example, Adam noted that: "the sport, flying, has taught me to know myself" (Adam). In essence all participants reported that extreme sports were responsible for profound and positive changes, not only in terms of behavior and positive psychological outcomes but also in terms of changes in values and identity.

Transferability of Capabilities

According to participants in this study, the skills required to fly safely and effectively in proximity flying flow over into everyday life. For some this was a direct transfer of skills such as the skills required to manage emotions and the practicalities of emergencies, for others flying provided a new perspective and insights on how to manage everyday life problems and emotions. For example, Adam determined that the skills honed through flying can be used 'to prepare myself for doing a lecture,' or even to guide his interpretations of what others might be feeling when being challenged.

It is hard work to eliminate human mistakes and to perfect myself; my body, my head, and my mind, to an immense task. And the work that I do to fly, I can copy that to other tasks in life. It can be to prepare myself for doing a lecture, or using the ability to maybe understand another human being; to see when they might be on their edge, on their exit point, ready to jump. Well, metaphorically. . . Or if it's driving or being in a meeting, or going on a date. The sport has made me see other people better. . . I feel that I am better at understanding when other people have a hard time . . . I can see if they need a supporting hand or a talk or even a kick in the butt. *laughter* (Adam)

In the same vein, Eric and Chase related how the skills required to harness and work through fear in flying were the same ones used in everyday life. Learning how to manage fear teaches that all challenges are surmountable and provides a medium to flourish. Chase described how planning required for successful flying supports the ability to simplify challenges to reveal more easily managed chunks. Chase exemplified this through his description of a typical situation where the transfer is direct and most obvious:

If there is an accident, I can very calmly deal with the situation and then, afterward, you can deal with your emotions and all that. But during that period of time: You go in and you're calculated. (Chase)

The skills required to fly effectively transfer into everyday life in many ways. For example, flying comes with intense emotions such as fear. Managing the effects of fear in flying is essential for effective participation, however, as Chase informs us in the quote above the skills learnt through proximity flying are not confined to the extreme sport context, they are also transferable into everyday life. Participants noted that experiencing human flight helps them to gain a new perspective on and develop effective skills for everyday events. The skills required to break down a flight can also be used to resolve problems and manage the most mundane or the most challenging everyday situations.

Life As Meaningful

The transformations experienced go beyond behaviors and skills. Participants indicate that the changes are fundamental whereby life and the certainty of death have facilitated new meaning and values. For example, Dave spoke about fundamental values guiding life choices. Chase noted:

None of that shit (materialism) actually matters at the end of the day. . . . Just friendships, memories, experiences, you know. . . I think as extreme sports people we get to appreciate that a little bit more than the most. . . You just realize that life is finite, and there is an ending. We ARE all gonna die, that's a fact. But it is all about how we LIVE, that actually matters. A lot of people don't realize that they're gonna die until they're sixty something, and they've wasted their whole life on working in a cubicle. (Chase)

Here, Chase seems very clear that his desire to consciously choose how he lives his life is directly related to the realization that death is unavoidable and inevitable. Proximity flyers in this study report that not only is every proximity flight an active choice to embrace life but that proximity flying enhances the way they live their everyday life. Expanding on this Chase describes how everyday life is appreciated more deeply and enjoyed more. Chase puts this succinctly:

I will never be bored. I just like to go for a walk and I like to play music. I like to ride my bike and I like to climb. If I am by the ocean, I can walk up and down beaches all day. I go for swims, surfing. . . I will never be bored, cause I enjoy it too much. (Chase)

Chase perceived that proximity flying facilitated a love of life where the enjoyment he feels in life means that even seemingly mundane activities facilitate pleasure. Chase does not imply that he needs proximity flying to ensure that he is never bored but that meaning and joy can be found in less extreme activities such as walking by the ocean. For Chase, the new perspective on life gained through proximity flying enriches all aspects of his life. Fred describes this in terms of a realization that leads to a choice. Proximity flying acts as the facilitator to a realization that life is short and death is inevitable which in turn leads to a choice to use this as a reason to be sad or to live life and enjoy life.

I simply take a giant leap back and look at the reality: nothing is made to last, and we are all gonna die someday. You, me, my parents, my brother, your lover, everyone! So either you have a breakdown or you're sad for the rest of your life, or you admit that reality and choose to enjoy, live, and love the rest of the tiny spark that is our short life in the infinite universe. (Fred)

In the quote above Fred shared a philosophy of life, which may have come to him through his involvement in proximity

flying. His views are consistent with a meta-perspective, and thus give meaning to his involvement in extreme sport. This meta-perspective is consistent with the notions described by Wong (2008), who theorized that a positive acceptance of the reality of death can lead to a life lived with joy and meaning.

Emergence of Selfhood

Extreme sport athletes often describe the experience of transformation as deep and profound, altering their sense of identity. For Adam flying is described as a central aspect of identity, a defining aspect of being free to be human:

> The sport, flying, has taught me to know myself. I have come to know myself physically and mentally; my own patterns of reaction. I know myself all the way out to my fingertips, all these tiny movements. Or, I am aware of my own reactions when I am full of adrenaline and happiness, or full of fear. (Adam)

In the above quote Adam explains that proximity flying has facilitated a deep understanding of who he is in the world, physically and mentally. Adam does not suggest that proximity flying changes who he is and makes him into something new but that the experience of transformation is more of a realization of profound self-knowledge. Eric uses metaphor to describe this in depth:

> It is like, it is who you are . . . What I think about when I see a bird that is caged, you know . . . A beautiful bird that is meant to fly, and he is caged. (Eric)

In the quotation above Eric draws on the metaphor of 'caged bird.' The 'cage' reflects a sense of limitation and has long been associated with terrestrial beings. The "bird" has long been linked to the potential ideals of freedom and inspiration often allied to flight. Eric uses the metaphor as a way of explaining that proximity flying is associated with the release from imposed normative constraints. Proximity flying represents freedom and capacity to explore beyond the realms associated with constrained beings. His metaphor encapsulates a fundamental aspect of who we are as humans, that is, the duality of limitations but also the potential for profound freedom.

DISCUSSION

Phenomenology seeks to give expression to lived-experience from a human science perspective. This requires that we "bracket our assumptions" as far as we are able and adopt methods consistent with psychology as a human endeavor. Furthermore, phenomenology assumes that humans have the potential for transcendence, in that we are able to gain a reflexive understanding of our own actions and understandings (Brooke, 2017). Participation in extreme sports is a prime example of human endeavor where individuals face their limitations and engage in an activity which challenges traditional notions of what it means to be human, that is, in the current context to move from artificially constrained beings to living more authentic lives. In this context, the findings from participants in this study point to the possibility of profound changes resulting for participating in such activities (Willig, 2008; Allman et al., 2009; Brymer and Oades, 2009). The motivation, attitudes, and skills realized through proximity flying, as also reflected in other extreme sport contexts, were not just context-specific but have been shown in related studies to exert positive influence in the everyday lives of athletes in a variety of social settings (Brymer and Schweitzer, 2017). The explication of the experience of participants in the current study illustrates the ways in which participants develop greater capabilities, grow as human beings, and transfer skills developed through learning to be effective in human flight, into their everyday lives.

For participants in this study, proximity flying has provided a medium for momentous realizations. As Willig (2008) reported extreme sports participation has the potential to facilitate deep meaningful discoveries about who we are and how we interact with our world. Rather than focusing on more traditional understandings based upon risk taking and the 'extreme' life, pushing boundaries and living on the edge; wingsuit pilots in this study were resolute that proximity flying affected them positively and facilitated the realization of the most profound aspects of self previously hidden from view (Holmbom, 2015, unpublished). The findings in this study are consistent with the notion that particular events may be instrumental in facilitating awareness of a deeper sense of self resulting in a profound and personal experience of transformation. These experiences are thus consistent with the transformative hypothesis previously posited (Brymer, 2013). Proximity flying affords fundamental changes in (1) a pilot's sense of self and lived experience, (2) the way they make sense of the world, and (3) how they interact with the world.

Through participating in the extreme sport of proximity flying, participants in this study describe the development of a clearer perspective of personal values and understandings of life. Proximity flying, affording the experience of being close to the potential of one's own death, facilitates profound self-awareness and a desire to live every day authentically. That is, a process of integration of the self and an experience of eudaimonic wellbeing. This notion is reflected in MMT (Wong, 2008) where the positive acceptance of death facilitates joy, wellbeing and meaning through a better understanding of personal wants, needs and desires.

While the findings from this study provide a glimpse into the possibilities realized through extreme sports and in particular proximity flying there are limitations that need to be recognized. A critique of the phenomenological approach is that the findings cannot be generalized to a broader population. Equally, phenomenology does not claim to link cause and effect. However, by linking the explication of lived experience to established theoretical frameworks phenomenology provides a deeper understanding of the lived experience of phenomena. Future research should develop the concepts explicated in this study to determine the capacity for extreme sport experiences to facilitate profound and life enhancing transformations more broadly.

Research into the extreme sport experience is still in its infancy and a great deal more needs to be investigated; future studies might explore exactly how extreme sport participation triggers personal transformations. Participants suggest that opportunities to experience vulnerability, connection, and the potential for death are important. Future studies may enhance our understanding of processes involved in facilitating transformation, the essential elements of the process and how these elements may be manipulated. This is, of course, not to suggest that the only way to achieve transformative experiences is through extreme sport, no doubt, there are many approaches which will lead to similar outcomes. Future studies might also investigate the link between extreme sport participation and human health and wellbeing as the transformations reported indicate that participants gain personal health and wellbeing, and social benefits from participation.

CONCLUSION

In recent years, research into extreme sports has revealed that the experience is both more complex and more profoundly rewarding than previously assumed. For the most part, research has focused on motivations for participation and explicating the lived experience of the extreme sport activity itself. While some studies have pointed to the possibility that extreme sport participation might facilitate profound and positive transformations in the everyday lives of participants, the lived experience of this transformation has attracted less attention. This study undertook to describe the lived experience of the everyday lives of proximity pilots. Pilots describe enhanced self-awareness, and changes in values and identity that they perceive to result from their experience of human flight. Pilots describe experiences that reflect a sense of the phenomenological concept of authenticity. It may well be that certain events that have the potential to bring humans nearer to the reality of their finitude are also life-changing and enhancing experiences. The experience of transformation experienced by participants through extreme sports emerged as being connected to a realization of a deeper sense of self. This sense of self may well emerge in response to challenging the dictates of who participants 'should' be and how they 'should' lead life. We have argued that the extreme sport experience strips away the socio-cultural noise and allows an individual to hear an authentic own self. As such, the findings have implications for a broader population, as all humans have a potential to consistently realize their own authenticity through a range of modalities, which do not necessarily involve such extreme sports. However, extreme sports have the potential to provide a mirror of the ways in which human experience may be both challenging and also provide a greater understanding of human potential across multiple domains.

ETHICS STATEMENT

This study was carried out in accordance to the requirements of Umeå University and the Swedish Research Council. All participants received written information concerning informed consent before agreeing to being interviewed.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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A Qualitative Approach on Motives and Aspects of Risks in Freeriding

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Recent research has shown that there are multiple motives for participation in high-risk sport; however these results have come from studies that consider a number of different sports. Therefore, the aim of the present study was to better understand the motives and risk-related aspects of freeriding, using a qualitative approach. Semi-structured interviews were conducted with 40 professional and semi-professional freeride skiers and snowboarders. All freeriders were highly experienced, of different age (19–44 years; 27.5 ± 4.5 years), gender (female = 13), and profession (professional athletes = 11). Analyses were done using MAXQDA software following a code theme approach. Mixed methods analyses using χ^2-tests were computed for age (<25 years ≥) and gender (female/male) on motives and risk factors. Five emerging themes were found, namely Challenge (n = 36), Friends (n = 31), Nature (n = 27), Balance (n = 26), and Freedom (n = 26). A sixth theme Habit (n = 13) was allocated as a subtheme due to minor responses. With regard to risk management, participants decided upon a risk calculation strategy which included multiple factors (e.g., planning, conditions, current situation, knowledge, and experience). Trusting in one's own abilities, avoiding negative fear and having trusted partners were among the risk factors. Deliberately seeking out dangerous situations was not a motive. χ^2-tests revealed no gender or age differences regarding aspects of risk (range of p-scores: p = 0.17–1.00) or motives (p = 0.16–1.00). Freeriding was shown to provide positive effects through participation. Some important factors seem to be motivational drivers for freeriders: challenging oneself, experiencing nature, contributing to deep friendships, freeriding as a counterbalance to everyday life and escape from restrictions. Contrary to prior research reports on sensation seeking, experienced freeriders do not search the risk; they seem to minimize it based on knowledge and experience. Analyses of the present data did not show any gender or age differences, which may suggest that experience plays a more important role in high-risk sports than age or gender. Future research should qualitatively investigate further terrain based activities and implement motives and risk-related factors in quantitative research.

Keywords: high-risk sport, extreme sport, skiing, risk-taking, risk-management

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INTRODUCTION

Freeriding describes skiing and snowboarding in undeveloped natural spaces (Reynier et al., 2014), jumping from sheer cliffs (Brymer and Schweitzer, 2013a), and involves the risk of serious personal injury or even death, through avalanches or other natural hazards (Haegeli et al., 2012). The term *freeriding* is widely understood and accepted in snow sports and is included in the name of major competitions (e.g., "Freeride World Tour," "Freeride World Qualifier"). Freeriding is also referred to as *out-of bounds skiing* (Haegeli et al., 2012) and *backcountry skiing* (Techel et al., 2015).

Freeriding is often categorized with other sports such as, BASE jumping, mountaineering, big wave surfing, etc., however, no common moniker is used in the literature for these sports; some researchers use the term *extreme sports* (Pain and Pain, 2005; Willig, 2008; Brymer and Schweitzer, 2013b,a), others choose *adventure sports* (Heggie and Caine, 2012; Kerr and Houge Mackenzie, 2012), and others *high-risk sports* (Castanier et al., 2010; Woodman et al., 2013; Barlow et al., 2015). In this paper we will use the term *high-risk sport*, which Breivik (1999, p. 10) defined as "all sports where you have to reckon with the possibility of serious injury or death as an inherent part of the activity," thus, freeriding can be considered a high-risk sport.

Participation in high-risk sports is generally voluntary and participants usually know what the hazards involved are. Personal knowledge and technical skills allow participants to manage their exposure to these hazards within reason (Haegeli and Pröbstl-Haider, 2016). Traditionally researchers have suggested that all high-risk sports participants are sensation seekers (Zuckerman and Neeb, 1979; Llewellyn and Sanchez, 2008; Zuckerman, 2008). However, recent research in high-risk sport has shown that although this may hold true for some high-risk sport participants (e.g., skydivers) there are also a number of other behavioral and motivational antecedents of participation for others (e.g., emotion regulation for mountaineers) (Lafollie and Le Scanff, 2007; Llewellyn and Sanchez, 2008; Woodman et al., 2009, 2010; Castanier et al., 2010, 2011; Kerr and Houge Mackenzie, 2012; Barlow et al., 2013, 2015; Brymer and Schweitzer, 2013b; Ewert et al., 2013; Wiersma, 2014). Motives not only varied between activity types but also between experience level of participants (Ewert et al., 2013).

There is evidence in recent literature showing psychological benefits from participation in high-risk sports [e.g., affect regulation (Castanier et al., 2011) and emotion self-regulation (Cazenave et al., 2007; Woodman et al., 2009, 2010; Castanier et al., 2010, 2011; Barlow et al., 2013, 2015)]. Recent qualitative studies have shown further positive effects of participation in high-risk sports (Brymer, 2010). Brymer and Gray (2010) described how high-risk sport participants develop special relationships with nature. One possible explanation for this is that the vast majority of high-risk sports are performed outside in the natural environment, this type of environment has been shown to provide greater physiological and psychological benefits than exercising indoors (Ryan et al., 2010).

Other research suggests that high-risk sports allow participants to: experience freedom and thus, explore fundamental human values (Brymer and Schweitzer, 2013b); experience fear and anxiety which has transformational benefits (Brymer and Schweitzer, 2013a); and develop courage and humility (Brymer and Oades, 2009). These studies were carried out with participants older than 30 years because previous research has claimed that young people (16–25 years) search for opportunities to take deliberate risks across a range of activities and the researchers wanted to control for this (see Brymer and Schweitzer, 2013b).

From a behavioral perspective most of the research conducted in this field has focused on risk-taking behavior. Risk-taking seems to comprise two orthogonal factors; *deliberate risk-taking* (e.g., skiing an avalanche prone slope) and *precautionary behaviors* (e.g., wearing safety equipment, reading the avalanche forecast) (Woodman et al., 2013). Paquette et al. (2009) found that both recklessness and safety were risk-related aspects of participating in snowboarding. Research into personality types has shown differences in risk-taking in high-risk sport participants (Woodman et al., 2009; Castanier et al., 2010).

Willig (2008) challenged the longstanding view of health psychology that risk-taking is a sign of psychopathology and suggests that risk-taking in high-risk sports can have psychological benefits through four main themes: *context*, *challenge*, *suffering*, and *other people*. These themes were elicited from interviews with eight high-risk sport participants; three skydivers, two mountaineers, and two who practiced multiple high-risk sports. However, Barlow et al. (2013) showed that skydivers and mountaineers have different motives for participating in high-risk sport, which means that it might be important to consider separate groups of high risk sport participants.

Some of the most recent investigations into the motives for participation in high-risk, have used a qualitative, hermeneutic approach with a mixed sample of participants in high-risk sports (e.g., Willig, 2008; Brymer and Schweitzer, 2013b). However, more recently researcher have suggested that high-risk sport participants should not be considered as a homogenous group (e.g., Cazenave et al., 2007; Llewellyn and Sanchez, 2008; Woodman et al., 2009, 2010, 2013; Castanier et al., 2010, 2011; Barlow et al., 2013, 2015).

Freeriding is becoming increasingly popular (Pain and Pain, 2005) and is the fastest growing segment in the ski industry (Vargyas, 2016). Total numbers of participation are unobtainable and thus no mortality rates can be calculated (Brugger et al., 2013). Whereas, the total number of avalanche accidents seem stable (see Procter et al., 2014), the number of avalanche fatalities through backcountry recreationists (e.g., freeriders, snowshoers, snowmobilers) is growing in some areas and the majority of victims were male (Jekich et al., 2016). This may be an artifact of higher numbers of male participants (as shown in Leiter and Rheinberger, 2016). However, little is known about freeriders' motives for participation, nor is much known about participants' risk-taking during participation. Raue et al. (2015) described a difference in risk perception between experienced and less experienced freeriders during a ski tour. Experienced freeriders risk-perception remained stable, before, during, and after participation whereas, less experienced freeriders perceived

the activity as less risky after participation than before. Raue et al. (2015) concluded that risk-perception is influenced by experience, emotion and by the current situation.

In high-risk domains there are a variety of hazards and the management of them is multi-faceted and the "boundary between acceptable and unacceptable is more gradual" (Haegeli et al., 2012); thus far attempts to identify people at risk in high-risk domains using questionnaires has been inconclusive. The present research sought to gain a better understanding of the motives for freeriding and participants perspectives on risk-related aspects. As earlier publications reported gender and age effects in high-risk samples, we were also interested in how, if at all, these variables are relevant in the population of freeriders.

METHODS

Participants

In total, 40 freeride athletes were interviewed ($M_{age} = 27.5$ years, $SD = 4.4$; 11 snowboarders and 29 skiers). Participants were selected using a combination of purposive sampling strategies, namely criterion-based and maximum variation sampling (Patton, 1990). This approach ensured that participants had specific knowledge and experience of the phenomena of interest whilst allowing the analysis of age and gender effects (Sparkes and Smith, 2014). The primary criterion was that athletes received sponsorship for freeriding. Participants included 11 (two female) professionals (current or former Freeride World Tour athletes or riding for international movie productions); 22 athletes (10 female) who still participated in qualifying events for the Freeride World Tour; seven freeriders (one female) who had stopped competing but were still sponsored. To examine age and gender differences participants included 13 women and 27 men; 12 participants 18–25 years old, 20 participants 26–30 years old, and eight participants over 30 years old. Due to ethical issues no underage participants (<18 years) were included.

Participants were informed prior to the interviews verbally and they received an information sheet according to the ethical guidelines of Helsinki which was signed at the beginning of the interviews. Approval by the Board for Ethical Questions in Science of the University of Innsbruck in accordance with the Declaration of Helsinki, was given prior to the study (No. 47/2016, Date 21.12.2016).

Procedure

A semi-structured interview was carried out with each participant. An interview guide was used to ensure that each participant was asked the same questions but also allowed them to talk freely about their experiences. The interview guide was developed by the research team based on existing research on high-risk sport participants. Three pilot interviews were conducted to assess the clarity of the questions and to familiarize the interviewers with the guide.

Interviews were carried out by three members of the research team. All bar two interviews were conducted in German, the other two were conducted in English as the participants felt more comfortable speaking English than German. All interviews were carried out one-to-one; 33 interviews were carried out face-to-face in a place of the participants' choosing; for seven interviews it was not possible due to geographic constraints to carry out face-to-face interviews. Therefore, they were carried out via Skype. The interviews lasted an approximately 30–40 min.

To build a rapport between the interviewer and participants, all interviews started with questions designed to the participant at ease (e.g., "How did you get involved in freeriding?") and were followed with questions about the experiences that they have had in freeriding (e.g., "Could you tell me about your experience in freeriding?"). Given the effect of personality on risk-taking (Woodman et al., 2009; Castanier et al., 2010), the following section asked questions about the participants' personalities (e.g., "How would you describe yourself?"). In the following section, participants were asked questions about why they went freeriding and what they enjoyed about it (i.e., their motives). Participants were also asked to describe a particularly poignant experience (e.g., "Can you describe one memorable moment of freeriding?"). The final section asked participants questions about their risk-taking. They were asked to talk about their risk-taking in freeriding recreationally, when filming, when competing, as well as in everyday life (e.g., "Do you have different risk-taking behavior when competing?"). Specific probes were used to ask participants to compare their risk-taking with other peoples, including other freeriders and people who do not participate in high-risk sports (e.g., "What do you think of your risk-taking compared to your friends?"). To reduce the potential for the researchers introducing bias to the results, interviews were conducted by three different researchers. Existing guidelines for conducting qualitative research were adhered to, in a further effort to ensure rigor (Elliott et al., 1999).

Analysis

All interviews were transcribed verbatim and analyzed in the language that the interview was conducted in (German, $n = 38$; English, $n = 2$); transcription was carried out immediately after the interview to familiarize the research team with the data. Interesting phrases were highlighted and any non-verbal communications was noted. The data was then analyzed in several distinct stages using MAXQDA Software (*MAXQDA*, 1989–2017)[1]. Firstly, the first author read the transcripts a number of times to immerse themselves in the data. Secondly, they carried out an inductive hierarchical content analysis, raw data themes were given codes (e.g., "being in the moment"), when there was not a suitable existing code a new one was created; in total 35 codes were created. Whilst the analysis was conducted in both English and German, all codes and themes were named in English language to reduce translation bias. This procedure was repeated for all 40 interviews. In the next step of analysis, all interviews were cross-checked, ensuring that coding was consistent and accurately represented the data. Following this, similar codes were grouped into themes ($n = 9$; e.g., *being in the moment* and *experiences emotion* were grouped into the theme *balance*; see **Figure 1**). The final step was to confirm the

[1]MAXQDA: software for qualitative data analysis (1989–2017). Berlin, Germany: VERBI Software—Consult—Sozialforschung GmbH.

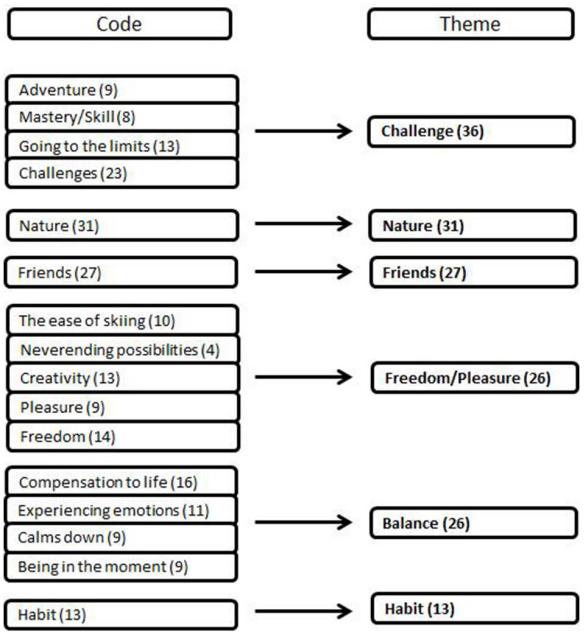

FIGURE 1 | Codes and Themes of motives in freeriding. Codes were only accounted as one vote per person. Thus, the codes do not necessarily sum up to the according theme.

codes and themes with the 5th author, who acted as a critical friend (Smith and Sparkes, 2009) and any disagreements were resolved by discussion. The only disagreement was about the name for the theme "Habit" and this was discussed until full consensus was reached. In addition to this, raw quotes have been presented in English, with the hope that the data will speak for itself and the voices of the participants might be heard. Gender and age differences in motives and aspects of risk were tested for using χ^2-tests (alpha = 0.05) in SPSS 23.0 (2015).

RESULTS

Participation

Almost all participants first experience of skiing was slope-skiing at an early age (2–5 years) with their families ($n = 37$). The majority of participants grew up in an alpine environment with an easy access to ski lifts ($n = 34$). Twenty three participants engaged in ski racing throughout their childhood (till 14–18 years) and stopped either due to an injury or motivational factors (e.g., "*too much pressure*"). Having already begun skiing, 11 participants started snowboarding during childhood. Participants started freeriding because of friends, family, education (ski instructor), new ski technology (freeride skis) or participation in freeride contests. Most participants ($n = 30$) said that their participation in freeriding was not due to one single event but it seemed to happen naturally.

Motives for Participation

Five main themes emerged from the code analysis of the data (**Figure 1**): Challenge ($n = 36$), Nature ($n = 31$), Friends ($n = 27$), Balance ($n = 26$), and Freedom/Pleasure ($n = 26$). A sixth theme, Habit ($n = 13$) was present in less than half of the interviews and thus, was a sub-theme. To test gender and age differences in motives, mixed methods analyses were applied. No statistically significant differences regarding gender (male/female) or age (below or above 25 years) were found (in all instances $p > 0.1$). Both male and female participants (Supplementary Table 1), as well as participants above or below 25 years (Supplementary Table 2), had similar motivations to go freeriding.

In the following section, themes will be explained and analyzed separately.

Challenge (36)

Experiencing the challenge of freeriding was the most frequently mentioned motivation; (90% of all participants; $n = 36$). Participants experienced *Challenge* in a number of ways: encountering new places with skis, exploring personal limits, experiencing mastery/skill, overcoming the challenges of environmental conditions, etc. (**Figure 1**). For some participants *Challenge* in freeriding was the opportunity to explore their personal limits. "Playing the mind game" (Female 9, 26 years, semi-professional) was one aspect of *Challenge*; being able to trust in one's own abilities when a mistake could be fatal,

> I wouldn't say what we wanted to ski was harmless. I knew I could ski this due to my technical abilities, but it is pretty intense to know when I do something wrong—then it's over; you're not allowed to fall. It's this mind game: I am able to do this but a lot could go wrong—this matters in freeriding (Female 9, 26 years, semi-professional).

Participants also spoke about exploring and stretching their limits as an aspect of *Challenge*,

> The thing is to work on your personal skills, improving your skiing and going to the limits of what is still possible. At first you think that's not possible, I can't ski that and then it works anyway and you have realized something which seemed impossible at first—this relocation of your limits (Male 21, 34 years, semi-professional).

Other participants stated that there were different ways of reaching their limits. Some people ($n = 10$; 25%) explicitly differentiated between trying to relocate their limits by improving their freestyle skills (e.g., jumping of higher cliffs, doing tricks above rocks and cliffs and being exposed in dangerous environments). When improving their freestyle skills, they were looking for a safe environment (in the backcountry) with relatively few natural hazards,

> I have a lot of respect for external factors, like avalanches. I don't risk much there. In other parts I risk more. For example when it is about jumping off of cliffs, I feel at ease there.… But I always look at it rationally: when there is a "no-fall-zone" or a steep face where you can hurt yourself really badly, I don't do it, because I don't feel good there. I take less risk there and rather put more effort in it when I know if I crash, it won't happen too much (Male 23, 23 years, professional).

This participant explained how he chooses the cliffs/jumps based on environmental factors and how his risk-taking varies based on the severity of the consequences of falling. When it was about skiing in more exposed and dangerous terrain, they stated how they would never just try it. This was explained by another participant who described the difference between jumping about obstacles in a safe environment and freeriding (referred to as Big Mountain Snowboarding).

> Street and slopestyle have other risks, there it is more about serious injuries. But in Big Mountain Snowboarding, when something goes wrong I'm dead; you can't really compare those risks. When it is about testing one's limits I can't just say "hey let's give it a try." This would be reckless (Male 3, 30 years, semi-professional).

The majority of participants ($n = 24$) talked about how they only did things they knew they were capable of. The more experienced they were, the more they knew about their limits and where they *"leave the gray area"* how one participant said (Male 3 semi-professional, 30 years). Although participants' behavior changed as they grew older, the same change in behavior was mentioned by younger, highly experienced freeriders. This suggests changes in behavior were based on experience and not on age. Knowing one's limits and believing in their own abilities is part of a risk management strategy.

> It is about experiencing my limits. This is a reason to go freeriding for most people. And because I played a lot in the backcountry I have a big repertoire of skills to get back to. That's why I can do stuff where a lot of people would have already backed off. My tool box is just bigger than those of others (Male 3, 30 years, semi-professional).

Participants ($n = 23$) felt that the challenge presented by freeriding was a positive thing and that it benefited them in their everyday lives.

> I get to know my own limits. That teaches you a lot about yourself (Female 2, 24 years, semi-professional);

> I always try to stay within my limits and not to overstrain myself. You get to know yourself in sports really well and you know what you are capable of, what you can dare to do and what not (Male 9, 23 years, semi-professional).

One participant highlighted a key difference between freeriding and other sports, many of the challenges in freeriding come from the natural environment rather than other competitors. Another participant reported how she preferred challenges posed by nature to those posed by other people and how this made freeriding different to other sports,

> Freeriding is not man against man like in other sports; it's rather man against the mountain and the challenge with the nature—that's just something I need (Female 8, 27 years, semi-professional).

Challenges presented by the natural environment require participants to understand the risks involved in freeriding. Whilst all participants said that they knew about the dangers of freeriding, some believed that they could minimize the risks through high levels of preparation and thought that they were less likely to be affected by a certain situation (e.g., avalanches). Others said "the mountain knows no conscience" (Male 9 semi-professional, 34 years), meaning that outcomes are never certain, no matter how well-prepared you are. Participants spoke about avalanche deaths of people who were experienced, well-prepared and seen as "safe," using this as evidence to suggest that there is always the chance of something happening,

> Last year, a good friend of mine died in an avalanche. This was really intense. He was one person who I felt was reliable and safe; someone I really liked to go skiing with. The avalanche factor—you just can't eliminate it (Female 9, 26 years, semi-professional).

The challenges participants faced in freeriding were described as complex and unpredictable due to the dynamic environment. The challenge of minimizing the risk was also part of freeriding and whilst participants did not seek high-risk situations they acknowledge the effect that risk has on them,

> I always want to minimize the risk…I try to make the risk as small as possible but I always know that there is a chance of something happening. And it can be falling from doing a drop or it can be a risk of avalanche coming down and so on...or just like skiing into the rocks… You always try to minimize the risk but there is always a chance that something can happen. And I guess that little chance is part of it; it gives you the adrenalin. Like if you would ski stuff that wouldn't give you any, when there was no risk in it, if you would have only stayed on the piste, yeah you can fall on the piste and break your leg as well but that is not exciting (Female 11, 27 years, semi-professional).

Nature (31)

Most participants ($n = 31$; 78%) stated that being outdoors in nature was a motivation to go freeriding. Freeriding allowed participants to explore and appreciate natural spaces in remote places that are only accessible on skis. Descriptions like "untouched nature," "uniqueness," "without manmade things" show how freeriding was about more than just being outside, but that it is also about being away from the built environment. Thus, being in nature, skiing outside of resorts, without lifts, and human disturbances was important to participants. When asked "Why do you go freeriding?" 20 participants simply said "nature." Others elaborated on this,

> For me personally it's the uniqueness of nature, it has always attracted me. Being able to ski this is a primary attraction (Male 19, 38 years professional);

> And then nature… I love being outdoors. If you do a splitboard tour and you are in untouched natural environment, there is so much tranquility (Male 4, 31 years, semi-professional);

> "Being out there without interferences, without manmade things.…You are truly in the nature, in the origin, in the untouched; no matter what weather." (Male 25, 41 years, professional).

One participant stated the uniqueness of being at the top of the mountains and not in the valleys.

> You are at the top and not in the valley. The moment when you stand on top and you see the sea of fog in the valley, this vast expanse it is just special" (Female 4, 24 years, semi-professional).

Friends (27)

The contribution of friends to the experience of freeriding was important to the participants and was mentioned by 66% ($n = 27$). Some participants ($n = 14$) described the value of friends in freeriding as a shared experience with people who experience the same passion. Others ($n = 12$) described the importance of shared trust in friends which was evoked through freeriding. They explained how they see freeriding not as a single sport because everybody has to rely on the partner(s) to have a higher survival chance in case of an avalanche. This mutual trust of being in a risk situation was mentioned and how it formed unique and deep friendships.

> Definitely it is skiing with friends, because skiing is no single sport.…When I go skiing with my friends somewhere then I have to trust my friends and my friends have to trust me. For me it is not just about skiing itself it is about who I go skiing with (Male 11, 23 years, semi-professional).

> But I think that it is the shared experience with people who already share your fascination with the sport. You get closer because you lay your life in the hands of the others if something happens." (Female 3, 28 years, professional);

> It builds up very intense friendships which get closer through freeriding and are filled with memories (Male 3, 30 years, semi-professional).

Freeriding showed participants who they could trust and whom not. They got to know people better and stated how they only chose to ski with people they trusted and felt comfortable with. This meant that the participants were also aware of group dynamics and with whom they could reasonably discuss risk situations with. Understanding group dynamics appeared to be an important part of participants' risk-management strategies,

> There are situations when I have a bad feeling and my partner has a good feeling then I ride it anyway although I wouldn't have if I had been alone, because I think my judgement isn't necessarily right. Then I trust the other person that my feeling might be wrong. But actually, that is only with one person, I don't trust most of the other people. There I trust myself more [laughs] (Male 7, 31 years, professional).

Another important factor when deciding who to ski with was, individual. This shows how the friends play a role even in preparation for the activity,

> Who I go skiing with plays an important role. Because when I do exciting runs I need the right partner to do it, I can't do that with just anyone. They have to be like-minded people and people who I get along with really well. Then I can do more extreme things and on some days, we'll do mellow things. Those friendships grow more intense through that experience and are more valuable than those you'll make when drinking coffee for example. They are like-minded people who go on an adventure with me and they are really close friends (Male 25, 41 years, professional).

Balance (26)

Balance ($n = 26$; 65%) described how freeriding functions as a counterbalance to everyday life. Some participants ($n = 16$) described the activity of freeriding as crucial for their well-being but could not explain why it was crucial. Two participants reported to have or have had withdrawal symptoms when not participating in freeriding. They just realized that when they did not participate in their sport, they felt sick and without any purpose in life. The sport of freeriding gave them a direction in life and was also part of their personality,

> I just had an inflammation in both knees and then you wake up in the morning and you are nothing, really nothing. If you can't ski and you can't do what you normally do, then you wake up and you would rather go back to sleep. The sport is extremely important for me that I am who I am, otherwise I am just really angry (Male 10, 23 years, semi-professional).

The impact of freeriding on personality was mentioned by participants in a number of different contexts, including in their understanding risk in their sport and how they were perceived by their families,

> Skiing is a big part of us and would you let it be, then you would change yourself. And the relatives probably know that. But you shouldn't act recklessly (Male 13, 29 years, professional).

"Being in the moment" ($n = 9$) was a counterbalance to everyday life too. Not having to think about anything other than what they are doing at that exact moment in time, in some ways similar to meditating. This allowed participants to concentrate on simple things and to be away from the hustle and bustle of modern society. This feeling of being in the moment and away from modern society was facilitated by being on top of the mountain and having some geographic space between themselves and the stresses of society. Participants described how skiing calmed them down, leaving them more at ease and relaxed. Suggesting that freeriding may benefit participants in their day to day lives,

> Freeriding has helped me in a lot of situations to conquer problems in everyday life, because those problems are not important up there anymore. It is just: "Am I doing it right or not?" "Should I ski this line or not?" Those are really reduced problems. It is like turning off the time (Female 2, 24 years, semi-professional);

> For me freeriding is my balance to everyday life. In the mountains, I know my way. There you are away from the valley and the

> trouble and you just have this calmness. I love to go up there (Male 16, 25 years, semi-professional);

> When I go in the mountains, I take my mobile with me, but I leave all worries, sorrows, and things I have to do at home. When I am back home from skiing, it's like having pressed the reset button. This is the time I have for myself (Male 21, 34 years, semi-professional);

> Freeriding is such a complex sport. You don't have time to think about anything else. You're not allowed to make any faults. That's why you are forced to be focused and concentrated and completely in the moment (Female 3, 28 years, professional);

> Skiing calms you down, you can reset, you are in the moment without thinking ahead or in the past. Everyone is stressed. If you go into the city you have to make sure that nobody runs you over. But it's like that, this is the pace of the society (Female 13, 28 years, professional).

Freedom/Pleasure (26)

Freedom seemed to be an important part of freeriding to many participants; 65% ($n = 26$) of participants spoke about the lack of rules and restrictions in freeriding and the importance of that to them. In ski resorts there are rules, boundaries, and often a lot of other people to watch out for. But outside of this restrictive area, participants felt that they had the freedom to decide what to do and where to go. With this freedom comes responsibility and freeriders had to take charge of their own actions,

> In the mountains, you can decide what to do; you decide the pace, whether it's going to be high, fast, steep, mellow. You decide (Female 13, 28 years, professional);

> There are no rules and restrictions, you don't have to ride blue or red, you don't have to train always and be fast. It is free in freeriding; you can do whatever you want. And if you don't think about contests there are no comparisons, everybody has their own style (Female 5, 27 years, semi-professional).

Participants ($n = 13$) also talked about how they could be themselves and be creative through freeriding. Being creative, could involve developing an individual style while freeriding or looking for creative lines to ski,

> I can live it up through skiing. To do what I want combined with the feeling that it feels great—self-expression with my own style without any rules (Male 5, 19 years, semi-professional);

> I am myself up there [in the mountains] and just the freedom of it (Female 2, 24 years, semi-professional).

A number of participants ($n = 4$) said that freeriding was a sport that never got boring; because there are never ending possibilities to learn something new. Some participants also felt that what they learnt from their freeriding experiences helped them in their everyday lives,

> It's a forever growing process and you can learn something every day. And also life-lessons for sure (Female 11, 27 years, semi-professional).

Some participants ($n = 4$) felt that it was cliché to say that they went freeriding to feel free, as "free" is in the name but nonetheless felt that this was an important part of it for them,

> …and it is this cliché feeling of freedom—that I am not sitting in my flat somewhere and watch TV the whole day; that is no life content for me (Female 6, 30 years, semi-professional).

The description of freeriders ($n = 9$) to ride untracked snow and feeling this pleasure of riding was also coded to the motive of freedom because it necessarily involved the freedom of the terrain. Inside the resort on groomed slopes you will not find the snow what the participants were talking about.

> Skiing for me is this unbelievable ease. Gliding through the snow; you kind of float down the mountain without a lot of effort. Doing jumps of 10 meters without so much strength (Male 24, 27 years, semi-professional).

> …the feeling of snow under your feet. To experience that feeling of snow under your feet when you do fast powder turns. (Male 17, 26 years, semi-professional).

Habit (13)

It was categorized as a realization of having always done the sport and could be explained like an acquired behavioral habit. Whereas, *Habit* was described neutral, all other five themes were seen as positive effects in freeriding.

Some participants ($n = 13$) spoke about skiing being something that their lives evolved around and how freeriding became habitual. They grew up skiing and were good at it, so never tried something different. Unlike the other five themes they did not see the habit of skiing as having a positive effect but nor did they see it as detrimental. Participants felt comfortable and happy with skiing and through freeriding they could participate in a new way of skiing,

> For me it's never been something I had to consider. Skiing was always normal for me and my favorite sport, maybe I also like playing football and surfing but like skiing I couldn't imagine doing anything else or anything else being more important to me (Male 20, 31 years, professional).

> I don't know anything else [laughs] (Male 13, 29 years, professional).

Aspects of Risk in Freeriding

Participants reported aspects of risk in freeriding such as risk-taking, risk management as well as different experiences of fear (**Figure 2**). χ^2-tests revealed no significant differences ($p > 0.05$) in risk aspects regarding gender or age. Both male and female participants described themselves to have a thoughtful and calculated risk management, experienced the same change in behavior through either external or own accidents or close calls.

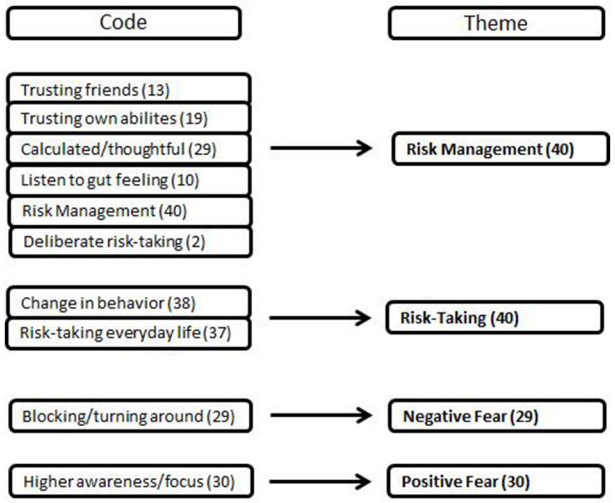

FIGURE 2 | Codes and Themes of aspects of risk in freeriding. Codes were only accounted as one vote per person. Thus, the codes do not necessarily sum up to the according theme.

Both cohorts also based decisions on their gut feeling and trusted their abilities. The same could be seen for the age below 25 and above 25 years.

Risk-Taking

Risk-taking was seen differently by participants depending who they compared themselves with. Some participants felt that they took more deliberate risks than the general public and that this was an inherent part of freeriding. However, when comparing themselves with other freeriders, most of the participants said that they do not take deliberate risks.

> I think I take a really high risk. You are not stronger than nature. In the backcountry, no matter how much knowledge and ability you have, there is always the chance of a serious crash, or avalanches, or changes in the weather. I think the risk is really high because you are exposed to nature (Female 4, 24 years, semi-professional);

> If you ask the general public if I am risk-loving, they'll certainly say yes. If you ask me I'll say no. I would never take a risk which I don't stand up for. Out of my view I'd say no, I am not risk-loving, but I have already invested a lot in the sport and can test my limits at a higher level. Thoughts about "am I the worst daredevil" have no place inside me (Male 3, 30 years, semi-professional).

When talking about risk-taking in everyday life, 17 participants said that they look for challenges in everyday life, but never take unnecessary risks. In the context of driving, 12 participants said that they do not speed because other people are at risk, whilst three participants said that they like to speed while driving and do not always follow the rules of the road. Most participants reported how they only take risks when they have an influence on the outcome, these participants felt that driving was more dangerous than freeriding and a less predictable outcome.

Eight participants said that freeriding gave them a better understanding of risk in other areas of their life. As one participant explained how the confrontation with risk in freeriding helped him to increase awareness in everyday life.

> I think when you are confronted with risk and the consequences of it you might get a higher awareness of what can happen and how you avoid it, for example while driving a car. I think to confront oneself with risk and the consequences of it, is safer than just throwing yourself into something without even knowing what could happen (Male 24, 27 years, semi-professional).

Nearly all participants reported changes in their risk-taking over time, either due to being involved in a freeriding accident or close call ($n = 23$) (close call as defined by Woodman et al. (2010, p. 480): "Close calls are incidents that come very close to resulting in a negative outcome but that fail to materialize into a negative outcome. As such, close calls are largely the same as an accident except for the outcome."), or through an external accident/fatality ($n = 14$) or simply through experience ($n = 14$).

Risk Management

The use of risk management strategies appeared to be an indispensable part of freeriding; all participants reported using risk management strategies, most described their actions as calculated and thoughtful ($n = 29$). Only two participants felt that their behavior could be described as reckless. One participant said that saying "no" to something was never an option, and that taking risks with the life was common as the risk of dying was accepted. The participant also felt that this was unlikely to change until a major accident happened. Another participant who was categorized as a deliberate risk-taker said that when there was a lot of snow (i.e., higher risk) he turned his head off but afterwards he would think about the things that could have gone wrong. Most participants described a risk-management strategy which followed a calculation strategy. Risk management involved a number of factors: information gathered prior to participation (e.g., weather forecast, snow conditions, terrain, etc.); participants' experience; group dynamics; and the current local situation. One participant explained this process really clearly,

> My [risk] assessment is based on my experience and on the information that I have. If I am in the backcountry, the steeper it gets the more components I have to consider and the more components have to turn green to be able to do it… So, the decision should be taken by the logic. This is a process. Is it basically possible and then you're considering the actual situation: "is it safe given the snow conditions?" This is how I make a decision. It is a rational thing. I always try to minimize it to an acceptable risk, but where this acceptable risk is, is my decision. You depend on your knowledge, your experience and your instinct (Male 3, 30 years, semi-professional).

Fear

Participants distinguished between positive and negative fear. Positive fear led to higher awareness, focus, and concentration whereas negative fear blocked actions.

> And when you start to panic, I've never really panicked but maybe it went a little bit in that direction from time to time, then everything is blocked—finished (Male 7, 31 years, professional).

Many participants tried to avoid experiencing negative fear ($n = 26$), when they felt that they might experience it, they turned around or made an alternate plan. Positive fear was seen as being aware of the dangers of freeriding and most participants ($n = 29$) saw this positive fear as something that protected them, as most injuries occurred when participants felt that they were not fully concentrated.

> It [fear] makes you hyperaware of everything around you, it makes your mind work faster you can consider things you otherwise wouldn't think about; it keeps you safe in a way, cause if you don't have fear you gonna do stupid things (Male 20, 31 years, professional).

DISCUSSION

The present study sought to identify the motives for participation in a single high-risk sport, freeriding. This inquiry revealed five main themes and one subtheme of motivation. All five of the main themes positively contributed to the experience of freeriding. Habit was classed as a sub-theme because only 13 participants spoke about it. Participants' acknowledgment that they had been very focused on skiing since the beginning was an important part of *Habit*. It was always a main part of their life and they never really considered the motives of participation because it was always their way of living or "normal" to practice it. Unlike the other themes, *Habit* was seen as neutral rather than positive or negative. Participants reported to have been skiing their whole life and all participants who named *Habit* as a motive had a background in ski racing. Since all of those participants started at a young age with skiing and racing, freeriding might have been their first opportunity to take part in a skiing discipline of their own choice. Participants saw starting freeriding as a "natural progression," rather than a deliberate choice; they could continue doing what they were good at (skiing) but had a new way of performing.

Deliberately seeking high-risk situations did not emerge as a motive for freeriding, but the challenge of developing risk-management strategies was seen as an integral part of the activity. All participants said that they were well aware of the dangers of freeriding and only one of the 40 participants reported taking deliberate risks. One participant explained that she knows the inherent risks in freeriding are part of the experience of freeriding and that it "gives you the adrenaline" (Female 11, 27 years, semi-professional). Whilst this could be considered evidence for sensation seeking, it was only evident in one participant's transcript, thus it was treated as a "side effect" in the present analyses. Since freeriders reported high preparation times for the activity without the presence of intense sensations, the theme *Challenge* comprises a more complex motivation which is about the mastering of the challenge rather than seeking sensations. Some participants differentiated their risk-taking between big mountain freeriding and cliff jumping in a more controlled environment. Whilst most participants stated that they generally choose to stay within their technical abilities, they were more likely to push their limits when jumping in a controlled environment where the risk was lower rather than when skiing in an exposed environment. Nevertheless, they reported to be well aware of their capabilities and only chose tasks which they knew they could manage. Participants were well aware of the risky nature of the sport and used calculated risk-management strategies. Factors incorporated in their calculations included, planning and preparation, the choice of partner(s) for the activity, the belief in oneself and one's abilities, experience, knowledge, and the seriousness of the situation. Whilst the dangerous nature of the sport contributed to participant's experience, none of them reported actively seeking dangerous situations. Minimizing the risk as much as possible was a goal named by 39 of the 40 participants. This suggests that the traditional "sensation seeking" explanation (Diehm and Armatas, 2004; Zuckerman, 2008) for participation in high-risk sport is not suitable for freeriding. Though the theme *Challenge* was the most named motive in participation, it was the challenge of avoiding rather than seeking life-threatening situations.

The theme *Challenge* was also identified in an hermeneutic approach investigating a mixed sample of high-risk sport participants (Willig, 2008), whereas that theme mostly included the code "going to the limits." The challenge with the environment and the "mind game" was not explicitly stated by Willig (2008) but seemed to play an important role for the participants of the present study. Brymer and Schweitzer (2013b) described how participants acknowledged the power of nature ("There is an appreciation that the natural world is much more powerful than the self" (Brymer and Schweitzer, 2013b, p. 871). Participants in this research also felt that it was important to respect the natural environment and also felt that this "positive fear" helped to keep them safe as it made them concentrate on the task at hand, thus making them less likely to have an accident or be injured. However, too much fear or "negative fear" led to situations where participants reported turning away from their objective. It is possible that "positive fear" represents a state of optimal arousal and that "negative fear" represents over arousal with accidents being more likely when participants are under aroused and therefore not concentrating fully (Yerkes and Dodson, 1908). Some participants reported their arousal comparable to the catastrophic curve (Hardy and Parfitt, 1991), with participants reporting their actions being blocked when they have too much fear. Participants understood the power of nature, stating that there is always a chance that something could go wrong. They also understood that even if you are highly experienced you still need to prepare fully as "*The mountain knows no conscience*" (Male 21, 34 years, semi-professional). Some participants lost friends or experienced their own close calls, following these events, they changed their behavior. Others said that their behavior was constantly evolving,

changing with every new experience. This is comparable with the findings of Willig (2008) who stated (p. 695) "The experience of extreme sport, then, involves reflection and monitoring of one's developing capabilities." Participants stated that they reflected on their experiences and that negative experiences were more likely to lead to a change in behavior. Interestingly, changes in behavior were related to experience not age. This means that at least in freeriding and maybe in other high-risk sports which involve knowledge and skills, the belief that younger people will be more risky might not hold true. Freeriding might teach also younger people after some years of practice to make educated choices about risk situations.

There are some similarities between the results of this study and those of Willig (2008) however, some of the motives for freeriding were not uncovered in Willig's (Willig, 2008) study of a mixed group of high-risk sports participants. Both studies showed that other people played a role in participants' motives for taking part in their sport. In Willig's (Willig, 2008) investigation the presence, or absence, of people was important in setting the *context* for participants whilst in this study freeriders said that it was very important that their friends contributed to their experience. In this study, the contribution of friends to the experience was either mentioned as a shared experience with like-minded people, or as a shared trust between friends in freeriding. It was reported that because of this shared trust, freeriding helped to develop deep friendships. This was illustrated by a participant as following:

> Those friendships grow more intense through that experience and are more valuable than those you'll make when drinking coffee for example. They are like-minded people who go on an adventure with me and they are really close friends (Male 25, 41 years, professional).

Having trusted partners in freeriding is also part of their reported risk-management. In avalanche accidents, it is usually a member of the victims group, if not the victim themselves, who triggers the avalanche (Zweifel and Haegeli, 2014). Furthermore, participants knew that having a partner who is able to rescue them from an avalanche quickly is crucial for survival, as highest survival rates were found in victims who were rescued within the first 15 min of burial time (Procter et al., 2016). Thus, it is important that freeriders choose the right partner(s); participants in this study reported this as part of their risk-management strategies. Sometimes it was only after an accident or close call that participants realized who they could actually trust. Being involved in an accident or close call made participants more careful about who they went freeriding with.

Previous research has not explicitly identified *Friends* as a motive for participation in high-risk sports, nor as a factor in risk-management, however this research has clearly demonstrated the role of friends in both. One explanation for this could be that the present research used athletes from a single sport, freeriding, which some participants described as a "*social sport*" differentiating it from other sports where people competed against one another. Willig (2008) noted that differences in social aspects were seen between sport types. Whereas, the skydiver focused more on camaraderie, the mountaineer focused more on the flow experience.

Being in nature was another motive for freeriding. Brymer and Gray (2010) described the importance of nature to the high-risk sport participants. "Participants seem clear that extreme sport participation provided a context for appreciating humanity's connection to the natural world and the realization that humanity is just a small part of the greater whole" (Brymer and Schweitzer, 2013b, p. 371). The findings of the present research support these studies. The vast majority of high-risk sports are practiced outdoors in nature and participants described how they value the untouched nature. Thus, one might assume that they gain a richer understanding of environmental factors and might further try to protect their environment which is crucial for participating in freeriding ("*and taking care of the nature. For me it's important to be clean.*" Male 6, 24 years, semi-professional). Being in the outdoors, in areas of nature untouched by humans, might also serve as a counterbalance to the built environment which is present in everyday life.

Having this counterbalance was important to participants; it was further shown by the theme *Balance*. "Being in the present" was one aspect of *Balance* as concentrating on the task at hand allowed participants to forget about day-to-day stresses. Similarly, forgetting problems in everyday lives was reported as a positive effect of participation by Big-Wave Surfers in California (Wiersma, 2014). "Being in the present" was also discussed by Willig (2008), she showed that regular participation in high-risk sports was therapeutic, and reduced stress levels and concerns. Participants in this study described how freeriding helped them to cope with their lives, and how they felt like they had lost something if they could not participate in their sport (e.g., due to an injury). This suggests that freeriding provided some regulatory benefits to participants that transfers to the rest of their lives. Other research has shown that high-risk sports can help participants deal with their day-to-day lives (Woodman et al., 2010; Barlow et al., 2013).

Contrary to findings of previous studies, participants in the present study did not report being obsessed with freeriding. Whilst withdrawal symptoms have been reported by climbers when not participating (Heirene et al., 2016) only two participants reported them in this study. The seasonal nature of skiing may prevent participants forming the same attachments with the activity as participants of perennial activities do, in addition to this participants said that they practice different summer sports, namely mountain sports which could be performed in the surrounding environment (e.g., mountain biking, climbing, mountaineering, paragliding etc.). The same number of participants named the motives *Balance* and *Freedom/Pleasure* ($n = 26$). Freeriding provided participants in this study with an opportunity to experience freedom as they could decide: where to ski, how they skied, and who they skied with. This sense of freedom might also be described as a sense of agency. Experiencing agency has been identified as a motive for participation in mountaineering (Barlow et al., 2013). Having no restrictions meant to be responsible for the own actions. similar to the theme *freedom as choice and responsibility* identified by Brymer and Schweitzer (2013b).

This research is the first qualitative inquiry to examine the effect of age on the motives for participating in a high-risk sport and no age differences emerged from the data. Other studies have controlled for age by limiting the age range of their sample (e.g., over 30 years old) as it has been reported that younger people (16–25 years) search for opportunities to take deliberate risks (see Brymer and Schweitzer, 2013b). The present research suggests that experience may be a more important factor than age in predicting motives for freeriding in adults (i.e., over 18 years). It is important to note that the age group used in the study is not entirely congruent with that of younger people (16–25 years), it remains unclear how the current findings relate to adolescents. Future research should examine the relationship between age, experience, and motivation for participation in high-risk sport.

χ^2-tests did not reveal any gender or age differences in motives for freeriding or in aspects of risk-taking and management in this sample of experienced freeriders. There are a number of possible reasons that no differences were found, it may be that the groups were too small, however there are a number of other possible explanations. It is possible that the higher fatality rates in men (Jekich et al., 2016) could be explained by gender differences in participation (Procter et al., 2014) rather than differences in risk-taking between men and women. This investigation only evaluated highly experienced participants and the variation in experience might not have been large enough to detect differences in risk-taking and management due to differences in experience. Raue et al. (2015) found differences in risk perceptions over time between experienced and less experienced ski tourers. Findings of the present analysis should not be generalized to less experienced freeriders, however, a logical extension of this study would be to repeat the study but with freeriders who had different levels of experience and to compare their motives with those of experienced participants.

Strengths, Limitations, and Directions for Future Research

Qualitative research is often used to examine issues in great detail and depth (Anderson, 2010). Using an inductive approach, as in this study, allows researchers to uncover factors that would go unnoticed in a deductive approach (Anderson, 2010). Two important strengths of this study are that it both examined a single sport and had a much higher sample size than many previous qualitative studies in high-risk sport (Willig, 2008; Kerr and Houge Mackenzie, 2012; Brymer and Schweitzer, 2013b; Jones et al., 2017). In addition this study included participants with a range of ages, gender, and profession levels, something few previous studies have done. However, readers should avoid generalizing the results of this study beyond highly experienced freeriders as it has been shown repeatedly that people have different motives for participating in different high-risk sports.

χ^2-tests were carried out with a relatively small sample and as such may be underpowered. Therefore, one obvious direction for future research within the freeride skiing population would be to better understand the relationships, or lack thereof, between age and gender with motives for participation and risk-taking.

Furthermore, research should consider the effect of experience on these relationships. In the wider high-risk sport population, further research should, as in this study, try to identify motives for participation in individual high-risk sports, which have remained hidden in analyses of heterogeneous populations. Researchers could also consider the influence of the environment and duration of the activity on this.

CONCLUSION

This study has shown that freeriders experience several positive effects of freeriding. Challenging oneself, experiencing nature, building deep friendships, a counterbalance to everyday life, and escape from restrictions were driving motivations named for participation in freeriding. Participation was not driven by a desire to seek out high-risk situations, but was about managing risk to an acceptable level thus, allowing participants to experience the benefits of freeriding. In examining a single high-risk sport (i.e., freeriding), two new motives for participation *(Friends* and *Habit)* were identified. Friends contributed to the experience of freeriding as like-minded people and as trusted partners from which deep friendships were reported. *Habit*, was characterized by the view that skiing had always been a part of their life and possibly not something that they had made a conscious decision to do with freeriding being a "natural progression". *Habit* held neither positive nor negative sentiment with participants and was only mentioned by 13 of the 40 participants. Analyses of the present data did not show any age or gender differences regarding motives of participation or aspects of risk in freeriding. This might indicate that experience and knowledge of the sport are much more important than age or gender. Some motives were similar to prior qualitative research in high-risk sports. Future research should evaluate further high-risk sport participants of different terrain based activities and compare their motives and aspects of risk and might implement those motives in quantitative research.

AUTHOR CONTRIBUTIONS

AF: Contributed to the conception of the research and study design. Collected the data, transcibed and analyzed. Wrote the draft of the manuscript in full. WH: Rewrote large sections, questionned and discussed the outcome and interpretation of the data. DP and F-GH: Collected and transcribed the data. MK: Contributed to the conception of the research and study design. Supervised the work and acted as a critical friend in all stages of the anlysis of data.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2017.01998/full#supplementary-material

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'Leave Your Ego at the Door': A Narrative Investigation into Effective Wingsuit Flying

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In recent years there has been a rapid growth in interest in extreme sports. For the most part research has focused on understanding motivations for participation in extreme sports and very little research has attempted to investigate the psychological structure of effective performance. Those few studies that have attempted to explore this issue have tested models designed for traditional sport on adventure sports. However, extreme sports are not the same as adventure sports or traditional sports. This study employed a narrative approach to investigate experiences of effective performance in the extreme sport of proximity wingsuit flying. An overarching theme we labeled 'leave your ego at the door,' emerged based on four sub-themes: (1) know thy self, (2) know thy skills, (3) know the environment now, and (4) tame the 'inner animal.' These themes are presented and discussed in relation to performance and discovery narratives identified within elite sport, thereby shedding light on how participants' experiences of the extreme sport of proximity wingsuit flying differ from dominant stories within traditional sports.

Keywords: wingsuit flying, extreme sports, self-knowledge, narrative, elite performance

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INTRODUCTION

Extreme sports are described as sporting activities where a mismanaged mistake or accident would most likely result in death (Brymer and Schweitzer, 2017). While extreme sports share some common ground with traditional sports, that of physical movement, they are different in many ways. In particular, (1) extreme sports involve considerable danger and the potentiality of death (Brymer and Schweitzer, 2013a); (2) extreme sports are not usually competitive in the traditional sense (Breivik, 2010); (3) while examples do exist of extreme sports being undertaken in urban environments (e.g., BASE jumping from buildings) for the most part they take place in the natural environment and demand that the participant engages with the natural environment (Brymer et al., 2010) and, (4) extreme sports are not governed by strict rules, regulations, and constrained performance environments as typically found in more traditional sports (Breivik, 2010). As such, extreme sports present different challenges than many traditional sports, which are compounded by the fact that more broadly adventure sport participation rates seem to be outgrowing many traditional sports (Wheaton, 2004; Pain and Pain, 2005; Brymer and Houge Mackenzie, 2016). Extreme sports are also different from other adventure sports. Though extreme and adventure sports share some larger common ground, that of physical movement taking place in natural environment, they differ in the degree of danger when doing the activity (Brymer et al., 2010; Brymer and Schweitzer, 2017).

For example, unlike traditional climbing, extreme climbing does not involve ropes or other protection and support. BASE jumpers jump off solid structures (such as buildings and bridges) without the aid of a second parachute or other safety devices more common in other parachute sports.

The majority of extreme sport research has focused on motivation for participation (Brymer, 2010; Kerr and Mackenzie, 2012) and used traditional theory-driven arguments frequently portraying the participants as thrill-seeking, reckless, self-destructive, and pathological daredevils. This traditional theory driven perspective on extreme sports is most often based on a deficit model and highlights the role of risk and risk taking as the main driver for participation (Brymer, 2010). According to this perspective, extreme sports are solely an outlet for individuals with an innate desire for risky experiences (Farley, 1991; Zuckerman, 2000; Woodman et al., 2010). There are many problems with this approach including that it does not reflect the lived experience of the participants and assumes that the main determinant of effective performance is the innate ability to handle risks (Brymer and Schweitzer, 2017). Recent research on extreme sports has revealed motivations that are more positive and life enhancing and suggests that effective performance is more than the innate ability to handle greater risks (Brymer, 2010; Kerr and Mackenzie, 2012; Brymer and Schweitzer, 2013a,b). Knowledge about these other functions is still limited.

Performance in Extreme Sports

While research examining effective performance in extreme sports is limited, researchers have started to reflect on how adventure sport athletes (recreational and competitive) perform optimally and in a manner that reduces the likelihood of serious mishap, injury or even death (Kabush and Orlick, 2001; Burke and Orlick, 2003; Griffith et al., 2006; Holland-Smith and Olivier, 2013). For the most part research has focused on applying psychological techniques used in traditional sports to the adventure sports context. For example, studies have investigated the use of imagery in skydiving and rock climbing (Hardy and Callow, 1999; Boyd and Munroe, 2003; Fournier et al., 2008), goal-setting in mountaineering (Bassi and Delle Fave, 2010), mental preparation in skiing (Coleman and Orlick, 2006) and coping skills in a multitude of adventure sports (Young and Knight, 2014). Although these studies provide some valuable insights, the focus has been on investigating the use of psychological skills in adventure sports where death is an unlikely outcome of a mismanaged mistake of accident.

To date no work has been undertaken on extreme sports as defined in the article, or wingsuit proximity flying in particular. It is possible that effective performance in extreme sports is different to adventure and traditional sports and that effective performance in extreme sports does not perfectly match effective performance in traditional sport or adventure. As such, similarly to the development of sport specific models of performance developed in the early days of sport psychology research (Dishman, 1983), it might be import to develop extreme sport specific models of performance. While valuable advances were made testing clinical and educational psychology models in the early years of sport psychology, the special characteristics of sport and relationships within sport required the development of sport specific models to speed progression. That is, findings from studies applying techniques from traditional sports to adventure sports might not reflect the lived experience of extreme sports participants. A decontextualized perspective on psychological skills that is purely about the awareness of and regulation of thoughts, feelings, and behaviors may not be ideal for the extreme sport athlete. Successful extreme sport participation entails more than efficacious task execution, as effective performance is also coupled with avoiding death through interactions with the environment based on a deep understanding of environmental characteristics (Brymer et al., 2010).

Narrative Research in Sport

Over the past decade, a number of narrative studies have been conducted into the experiences of elite sportspeople (e.g., Douglas and Carless, 2006, 2009; Carless and Douglas, 2009). This research has led to significant theoretical advances offering new understandings around performance, lifestyle, wellbeing and motivation. Because this literature has potential links to the findings and interpretations this study we provide a brief review below.

Across a variety of traditional sports at the elite/professional level (e.g., golf, rugby, swimming, track and field, rowing, hockey) a particular narrative type – the *performance narrative* – has been shown to be dominant (Douglas and Carless, 2015). Stories which follow the performance plot are most common in elite sport culture, and are assumed by many to be the only type of story high-level athletes can legitimately tell. These stories script a particular way of being which revolves around achieving performance outcomes to the extent that performance concerns come to infuse all areas of the athlete's life. Hallmarks of performance stories include a prioritization of competition, winning or being the best, discipline, sacrifice, hard work, technique, and the relegation of other aspects of life such as relationships, co-operation, enjoyment, exploration, play (see Douglas and Carless, 2009). An alternative narrative type – the *discovery narrative* – has also been identified which prioritizes a different set of values based around exploration and discovery. In this type of story, Douglas and Carless (2015) suggest, the storyteller prioritizes experiences over outcomes, describing a multifaceted self and a life full of people, places and experiences. Play, adventure, fun, feel and a diverse range of experiences characterize these stories. Success is achieved without prioritizing sport over other areas of life and performance outcomes are important only to the extent that they facilitate new experiences, discoveries and explorations (Carless and Douglas, 2009).

Purpose of the Study

This purpose of this study was to begin to fill the gaps in existing knowledge identified above through a narrative exploration of participants' experiences of effective performance in the extreme sport of proximity wingsuit flying. Wingsuit flying is a relatively new parachute sport involving a specially designed jumpsuit that facilitates forward motion and directional control. Proximity wingsuit flying has become increasingly popular and

is considered the most dangerous parachute sport as it involves flying close to structures at speeds of over 200 mph, which means that the pilot has little time to correct errors (Mei-Dan et al., 2013). Given the increasing popularity of extreme sports, it is important to obtain a clear picture of the psychological processes accompanying effective performance among successful extreme sports athletes. Lessons learnt in this extreme sport context also have the potential to enhance to open up new perspectives on performance related cognition and behaviors in other adventure and traditional sports. The study we present here (part of a larger study on the use and development of psychological practices by proximity wingsuit pilots) focused on understanding the psychological practices experienced extreme sport athletes employ to perform and to reduce the likelihood of serious mishaps. We chose a narrative approach which is premised on the belief that to understand wingsuit pilots' psychological processes – meanings, motivations, beliefs, and attitudes – it is necessary to take seriously their stories of personal lived experience, and within the lived experience certain practices lie.

MATERIALS AND METHODS

A narrative methodology was used to allow the participants to relate, in first-person story form, their experiences, practices and processes over time. A narrative is the general structure, template or scheme people draw upon to tell their personal stories (Smith and Sparkes, 2009). As a research approach in sports it has been used to explore various topics, for instance the coach-athlete relationship, sport identities, and Olympic experiences (e.g., Sparkes and Partington, 2003; Douglas and Carless, 2006, 2015; Jowett, 2008; Carless and Douglas, 2013; Kristiansen, 2013). The proximity wingsuit pilots in this study were asked to share stories from their lives in sport with the specific intention of explicating an understanding of the psychological practices of wingsuit flying.

Participants

Following ethics approval six pilots (aged from 30 to 45 years of age) from across Europe accepted the invitation to participate. Wingsuit proximity pilots were recruited based on three criteria. The first was that participants were experienced in proximity wingsuit flying, as this would warrant that pilots had a repertoire of relevant experience and events to draw on. The second criterion was participants' capacity and willingness for reflection. Third, the participants' English language proficiency needed to be at a level sufficient for understanding the questions asked and verbally communicating personal experiences and opinions with an English-speaking interviewer. Purposeful sampling was used (Patton, 2002). Initially participants were contacted based on demonstrated preparedness to engage in personal reflection, in English, such as discussing their philosophies or the mental aspects of sport (e.g., in previously published interviews, documentaries, or personal videos). Participants were also recruited though snowballing where potential participants were referred to the first author by other participants.

The years of experience as wingsuit pilots ranged from 11 to 22 years. All participants had registered more than 1,000 skydives and BASE jumps and were holders of national and international titles in different parachute sub-disciplines, including wingsuit flying. For confidentiality reasons a more detailed description of each participant is not provided as competitive wingsuit flying consists of a small group of easily identified athletes. The study was approved by the University Ethics Committee of the first author. All participants signed a consent form, before participating in the study, informing them in writing of the study purpose and process as well as their rights and obligations as participants. For anonymity, all participants chose a personal pseudonym to be used in all written reports.

Data Collection

A semi-structured interview process with open-ended questions was developed and pilot tested to check for content and fluidity. The initial interview questions were developed to guide the interview process by encouraging participants to tell their personal stories about the psychological practices of proximity flying while also allowing for "serendipitous findings" (Strean, 1998, p. 342). The first three authors worked to ensure that the questions were appropriately worded for the audience and the research objectives. The questions were used as a guide rather than as a structured process. The data presented in this paper emerged from responses to questions such as: 'Please describe in detail how you prepare yourself mentally and physically before a typical jump in wingsuit flying?' and 'Please now take me through a typical wingsuit jump as if I were in your mind. What do you think, feel, see, and concentrate on once you get air?'

Procedure

Pilots were initially identified via the World Wide Web and those who fitted the three inclusion criteria were sent invitations with a summary of the study. While the sport of wingsuit proximity flying is growing it is still anew sport and participants herald from all over the world. For reasons of high mobility and pilot time constraints, interviews were conducted using the communication software Skype. While the use of Skype in research has been critiqued for its limitations in terms of rapport building, its capacity to reach a broad participant group across a wide geographical area in a timely and cost effective manner does open up possibilities that the face to face interview is not able to do. Despite the limitations research has shown that interviews undertaken using Skype are comparable to face to face interviews (Janghorban et al., 2014). In this case, we found that Skype facilitated interviews with expert proximity pilots that we would not have been able to recruit because of geographical, financial and time constraints. With the participants' permission, all interviews were audio recorded and subsequently transcribed verbatim. Interviews lasted between 45 and 90 min and were conclude when first author and participants considered saturation had met. All interviews began with an outline of the intention of the research project and ended by asking if the participant had anything more they wished to add. Transcripts and additional clarification questions were sent to participants for comments (Culver et al., 2012). Three

pilots answered these additional questions in writing, while one pilot agreed to a second interview. The transcribed text of this interview was also sent to the pilot for comments. Two pilots said they did not have the time to respond to the additional questions. All pilots confirmed the final transcripts of their interviews.

Data Analysis

The initial stage of the data analysis process involved immersion in the data by listening to the interviews and reading the transcripts multiple times before starting the thematic analysis process. Following this, a categorical-content perspective (Hiles and Cermák, 2008) was utilized where the text was first broken down to relatively self-contained areas of content (we isolated segments that related to specific discussions during the interviews) before conducting a thematic analysis. The thematic analysis process followed recommendations outlined by Braun and Clarke (2006) for generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final report. The first author conducted the interviews and undertook the initial stages of the thematic analysis process. During analysis, another experienced qualitative researcher, not involved in the study, provided further regular feedback. Further analysis was undertaken with the other authors to explore the form of the stories participants shared. This allowed the form of individual participant's stories to be compared and contrasted to the more general performance and discovery narrative types discussed above. The identified themes were then sent to the wingsuit pilots for member reflections (Tracey, 2010). This procedure aimed to enrich the analysis process and ensure that the authors did not have sole ownership or power over the final interpretations (Willig and Stainton-Rogers, 2008).

Findings

The following sections explicate one theme from a larger study on the extreme sport experience which we have called 'leave your ego at the door.' This theme emerged from the analysis of the content of participants' accounts of their lived experiences of wingsuit flying. Four interrelated sub-themes emerged from the data: (1) know thyself; (2) know thy skills; (3) know the environment now; (4) tame the 'inner animal.' Taken together, these themes provide insights into the psychological practices that underpin pilots' survival (chances of living to fly another day), performance (effective participation in both recreational and competitive flying), and personal rewards (the benefits of wingsuit flying). Below, we consider these themes in turn, referring to pilots by their chosen pseudonym and omitting details that could make them recognizable.

Know Thyself

Wingsuit pilots stories reflected the ancient Greek aphorism 'know thyself,' sometimes described as the greatest form of knowledge, transcending time and context. The aphorism conveys deep knowledge of the self which for Socrates, as described by Xenophon (1923) and Plato (1982) in the Socratic dialogs, was the ultimate form of knowledge guiding a person's thoughts and actions. All pilots placed emphasis on learning to honestly tune into personal motivations and underlying values in the process of performing optimally. They elaborated on how the development of this kind of awareness is both a proactive and an ongoing process. Awareness of values and motivations is not only needed before undertaking the first wingsuit flight but further supports and guides their development. The ability to 'know thy self' underpins and fosters the process of mastering human flight.

For Medusa the continual process of tuning into 'why' he participates in wingsuit flying reveals that flying is something fundamental to living, something that he 'can't live without':

> I kind of tune into why I'm doing this. Like what is so special about this and why I do this? . . . I'm doing it because I love what I do and the feeling of flying is something I can't live without.

The sense of an activity that is experienced as special is also evident in this account from Pinky:

> When I'm flying for myself doing something new or just carving through terrain, I like to make noises to myself like [makes flying noises like "whoosh!"]. They enrich my experience as I like go carving past something or flying in between something. Keeps me in the moment and also makes me feel like I'm a child and I'm playing. It's one of the things adults forget to do is play. So when I'm jumping for myself, I do become a bit of a child, I make noises, I giggle, I laugh, when my parachute opens I scream and yell with joy when I've done something that pleases me.

While the *content* of these excerpts offers insights regarding the importance participants attached to knowing themselves, the *form* of the excerpts offers a second level of insight. In this sense, pilots' stories about 'knowing thyself' – as these excerpts illustrate – also deviated (in terms of form) from the dominant performance narrative type. Performance stories revolve around performance outcomes, technique, sacrifice, a future focus, hard work (Douglas and Carless, 2006, 2015). In contrast, Pinky describes how flying "makes me *feel like I'm a child and I'm playing*" while Medusa says "the *feeling* of flying is something I can't live without." These examples are not typical performance stories of hard work, discipline, sacrifice and competition. Rather, they follow the contours of the discovery narrative type, which prioritizes experiences of exploration, playfulness, joy, feel, surprise and immersion in the present moment (Douglas and Carless, 2006, 2015).

The discovery orientation evident in pilots' stories appears to be an important factor also in regard to their ongoing participation. Steve, for example, shared the following story as he reflected on pilots who have died:

> It's always the same question: Is it worth it? Is it giving me enough satisfaction and pleasure to be worth it? The day it would not give me satisfaction and pleasure, I would quit. But it's hard sometimes, especially this summer with all the accidents. You ask yourself a lot of questions.

His words reveal a practice of continually re-evaluating his connection to flying in order to reflect on meaning and purpose, perhaps as differentiated from something that drives a pilot to push his limits. Meaning and purpose, for Steve, does not revolve around the values of the performance narrative, but instead the discovery values. He explains how the core value that guides

participation stems from the question "Is it worth it?" For Steve, the deep internal sense of satisfaction, pleasure, and the meaning he gains from flying are key to participation and if these were not present he 'would quit.'

An affinity for discovery stories over performance stories was as well evident in participants' accounts that highlight the 'processes' of wingsuiting as being more important than the 'outcomes.' Participants recounted how tragic and unnecessary accidents often occur when the pilots are preoccupied with a desire to achieve a spectacular outcome (e.g., fly the most dramatic line before anyone else does and to share the act with the world). Even in competition, survival and life values prevail over pushing boundaries to achieve any short-term victory. Knowing thy self was discussed by all participants as foundational practice that was in danger of being overlooked and skipped due to the rapid pace of the evolution of the sport, its growing popularity, and the 'get there quickly' attitude of many potential pilots. This underlined a prediction that in the near future low knowledge and awareness of self might lead to increased casualties. As Christopher said, "Everyone in all extreme sports is skipping the processes now. But with BASE jumping this results in death, not just a broken ankle like in skateboarding." For Steve, pilots overlook self-knowledge and self-awareness because "lust for life is getting smaller than your lust for attention. It's an ego problem or it's just being really unconscious." Here, participants forewarn of potential dangers from pursuing to the extreme a performance story.

Know Thy Skills

The theme 'know thy skills' reflects participants' emphasis on the importance of understanding personal capabilities. Valuing technical knowledge is a key characteristic of the performance narrative (Douglas and Carless, 2015) and, in this way, pilots' accounts sometimes followed the contours of this narrative type. An important distinction, however, is the way that pilots often focused on knowing the *limits* of their technical skills and capabilities, rather than relentlessly seeking to maximize or 'push' their skills. This knowledge was seen as critical as making decisions based on a realistic perception of capabilities was described as essential both for performance and for keeping a pilot safe. They suggested flying without this knowledge leads to being out of control. Pinky exemplified this:

> You have to know your limits, otherwise you are just out of control. But I do believe that everyone with the right guidance has the capability of flying a wingsuit off a mountain. It's a very enriching experience, very rewarding; it allows you to focus on the now and live in the moment, forget about your worries in life and I wish that everybody could understand their position in the greater scheme of life.

In this excerpt Pinky describes how learning to evaluate and appreciate personal constraints (both facilitative and restrictive) and working within personal constraints while flying reduces the chances of being 'out of control.' His account also communicates a belief that wingsuit flying is less about talent or ability, and more about learning, development and the 'right guidance.' Finally, by contrasting flying to everyday life, Pinky related flying to a positive life enhancing experience associated with finding meaning in the 'greater scheme of life' which enhances the possibility of leading an authentic life.

All pilots emphasized that it was important to take time to develop capabilities before initiating wingsuit flying. The general attitude toward progression was voiced by Pinky, who emphasized, "slowly stepping it up and realizing that you don't have to achieve everything in one summer season. You can come back the next season and crunch a little bit harder again." The importance of 'slowly stepping it up' was exemplified by contrasting concerns about what might happen if the journey was ignored in place of the quick fix. As Christopher related:

> If you're pushing your own boundaries too quickly then you'll be like a horse with blinkers on. People need to go back and do all the steps and remember [it's] about the journey not the destination, because you can't get it back once you've learned it and learning it is so much fun. Getting your skills up! So people are missing the point. I'd say probably it's not about having big balls anymore, because the technology is so good. But it's about arming yourself with knowledge and longevity, and that's the key to a great career and happiness. It is about learning to see not just what is in front of you but what is all around you, and to not only see it but feel it as well. Sort of like a sixth sense. But you can't make this happen overnight. The 'bigger picture' can take years, if not a lifetime to get sorted.

In this quote, echoes of a discovery narrative are once again evident as Christopher describes the process of learning to wingsuit as a journey rather than an outcome, which leads to an awareness that facilities 'a sixth sense' or the ability to 'feel' what is happening all around. This is less a performance story of narrow, time-limited, goal-directed focus on a particular outcome or destination; more a discovery story of openness, learning, taking one's time and prioritizing the journey. For Christopher, it's "about the journey not the destination." Christopher's story transgresses the performance narrative further when he posits that macho attributes are not required and that focusing on performance outcomes can result in reduced awareness of capabilities which ultimately leads to greater danger. Pinky echoed this perspective, stressing that knowing one's capabilities is an ongoing process because it only takes one mistake to end a pilot's life: "You can always come back the next day and come a little closer. But you can't come back the next day if you've gone too close."

So while participants' stories within this theme share some similarities with performance stories (e.g., valuing personal capabilities and technical knowledge), they also differ in important respects. This difference, we suggest, revolves around the *inclusion* of a broader range of factors that pilots consider to be personal skills. While performance stories tend toward a relatively narrow focus on the self and one's technical capabilities (see Douglas and Carless, 2015), pilots' discovery stories portray a broadening, outward-looking way of being. Moving toward a discovery plot, the stories collected from these wingsuit pilots extend conceptions of what constitutes 'skill' in elite performance beyond the technical capabilities that a person possesses (as articulated in performance stories), toward deeper, more profound understanding of personal abilities. Pilots'

conceptions of 'skills' thereby incorporates values, processes, insights and personal motivations align more closely with discovery stories.

Know the Environment Now

A strong thread in participants' accounts was the need to know – to tune into and be aware of – the environment in which they find themselves at a particular moment in time. Participants described how attending to the external environment was essential for successful flying and that this awareness was actively developed rather than an innate or inbuilt ability. The pilots were adamant that 'tuning into' the present moment was not solely about connecting with internal states but also about being 'connected with the environment.' Steve exemplified the importance of this awareness:

> In a sport like ours it's a question of survival. If you're not perfectly in the present moment, if you're not ultra-connected with your environment, like an animal who's hunting, you take many more risks. Being able to be perfectly in this present moment will make you much more aware and basically much more efficient in what you are doing.

Steve vividly expressed this intense state of tuning into momentary environmental fluctuations with the metaphor 'like an animal who's hunting.' He is acquainted with the reality that his sport can result in death, and because of this, survival heavily depends on being attuned to potentially significant environmental factors. Dakota described how attending to the environment requires 'noticing' – focusing on and attending to – a broad range of environmental factors:

> I'm usually assessing the conditions so I'm noticing everything around me, if there's clouds, I'm noticing the trees, and if there's wind blowing, noticing if the birds are flying, where they're flying, how they're flying because that can give me a good idea if there are any thermals in the air or a decent breeze. Because all of this is going to affect me once I actually jump.

The performance narrative, according to Douglas and Carless (2015), is a story about overcoming through power and/or superiority, of striving to win regardless of the obstacles you may encounter – commonly by considering that obstacles are there for all and it is about the survival of the fittest (mentally and physically). In a performance story, they suggest, the athlete may be understood to be *in opposition* to all obstacles to success (competitors, conditions, injury, etc.). Yet these pilots' stories reveal a sense of trying to *connect* with – co-operate with – potential obstacles (such as weather conditions).

Steve described how his experience of time changes through the need to notice and weigh this ever-changing range of environmental factors:

> You're like in a tunnel. This 1 min seems to be 5 min. There's distortion of time, you are super sharp in your senses. In fact to me it's optimal focus with letting go of everything. Because you have to be in the present moment. There is no way you can multitask in such a survival-based situation.

The outcome of this process of noticing and weighing environmental factors prior to a flight is sometimes the decision to not jump at all. Bumblebee recounted how an experienced wingsuit pilot's decision *not* to jump had a powerful influence on his own decision making:

> A lot of times you might hike hours and hours to get somewhere, blood sweat and tears to get to an exit point and then the weather conditions just aren't right. Now a lot of people would [jump] anyways, whereas he was the guy that had no problems turning around and then hiking back down. And I remember the first time that happened in [location]. I was just shocked. I was just like, "But we're up here, it's not that bad. . .", and he was just, "I'm not feeling it (. . .) the winds are this and that, it's just not a good idea to go so I'll hike down and see you at the bottom." Just like "Waw!" You know, somebody like that I really looked up to in the sport of proxy flying had that kind of willpower. It really stayed with me.

Here again, the narrative form of participants' stories under this theme also contrast with the plot of performance stories. Pilots stories do not revolve around 'conquering' or 'overcoming' the environment or the weather conditions (as a performance story likely would), but instead they describe becoming aware of and responsive to these variables. Pilots' stories portray a sensitivity and responsiveness to what is going on around them. While the performance narrative might be understood to require performance *independent of* or *despite* external factors, pilots' stories follow a different kind of narrative plot which prioritizes awareness, responsiveness and co-operation.

Tame the 'Inner Animal'

While awareness and preparation during the time before the jump is important, a successful jump also relies on a dynamic process of continual re-assessment while flying. The theme 'tame the inner animal' reflects an ongoing awareness of one's inner states as well as environmental boundaries and individual capabilities that combine to support effective decision-making while actually flying. For instance, Bumblebee explained that, for him, success (i.e., effective performance) in wingsuit flying depends on the ability to manage the desire to push beyond one's capabilities:

> You can tell yourself everything you want when you're on the cliff edge, but once you jump and you start flying most people have that animal taking over where you [tell yourself] "You can make that turn, you can make that corner, you can make this" and you just "Go, go, go, charge!" And the people that live through this world are the ones who in that moment of nanoseconds and the surreal experience, have the mental power to realize that their inner animal is trying to convince them to maybe push it too far. So for me, being on a cliff edge, fighting that emotional battle of [thinking of] the whole family [back home] and "What am I doing?" is the glue that keeps me aware of that animal inside. That helps me not be that guy that tries to drag my toes through the trees, but instead stay ten feet off the trees.

Here Bumblebee used an animal metaphor to articulate the intense conflict that arises during flight. He described how a successful pilot is aware of two contradictory elements that need to be actively managed in order to constrain the craving to push beyond limits and potentially tempt death. According to Bumblebee a pilot's awareness and mental strength must work

collectively within 'nanoseconds' to preserve safety. Christopher also articulated this conflict and emphasized that being aware of inner states and personal capabilities enhanced safety for him:

> I try not to push past my limits, I try and just run it 50–70% all the time to ensure my safety. I don't run it a 100%. I could do so much more with my abilities and just my skills over the years, but I've seen so many of my friends die because they were running at 100% that I don't want to do that. I just walk away. If you're running at a 100% then you've got nothing left. And then if you hit a flat spot on a wingsuit flight and you're running at a 100%, you are in big trouble. I think you've got to leave your ego at the door with a lot of these sports.

'Leave Your Ego at the Door'

In the preceding excerpt Christopher used the phrase '*leave your ego at the door*' to express concisely and evocatively a notion that other participants also raised, that a successful flight is about holding back, to perform optimally *within* maximum capacity. This act of balance between awareness and regulation means that while the pilot knows he can do more he deliberately retains a margin which provides the capacity to resolve unexpected issues. All interviewed pilots reported that it was imperative to be aware of skills and to accept limits at all moments during the flight. We see this point as important and, once again, something of a deviation from culturally preferred and endorsed performance stories in sport such as 'no pain, no gain' or 'just do it.' These wingsuit pilots stories are about *not* 'pushing to the max,' *not* 'just doing it' in conventional elite traditional sports terms, to instead be aware and judicious of the four themes discussed above – in essence: oneself, one's skills, one's immediate environment, and one's ego.

In this sense, 'leave your ego at the door' may be understood as a *foundational way of being* for wingsuit pilots which starts (and progresses) with the deliberate intention to tune into personal motivations and values as well as skills and capabilities. To achieve this foundational way of being, pilots' accounts suggest that the four sub-themes discussed above needed to realized. In other words, when pilots were able to attend to knowing themselves, knowing their skills, knowing the environment and taming the inner animal, they were able to 'leave their ego at the door' and perform optimally. This way of being has a temporal configuration characterized by an active process of becoming and being increasingly aware, sensitive, conscious, attentive, alert, and responsive to self, skills, environment and motivations. While the essence of the experience happens during each flight, the process required for effective flying can take years to develop. This development is active and ongoing, perhaps most clearly evident when pilots described their personal preparations for flight. As Bumblebee exemplified, the preparation process includes reflections on personal values and meanings – an ongoing connection with his being – that keep his flying safe. He shared how the conflicting emotions he feels before jumping, tempered by thoughts of his family, mediate what he does while jumping:

> For me, being on a cliff edge, fighting the emotional battle of [thinking about] the whole family [back home] and "What am I doing?" is the glue that keeps me aware of that animal inside me. This helps me not to be that guy who tries to drag his toes through the trees, but instead stays ten feet off the trees.

Medusa also described how he deliberately attempts to center himself and to be at one with the self and the environment:

> I like to actually go and close my eyes at the exit point that I'm going to jump [off] and take deep breaths and feel the air, which way the air is moving. Feel the air toward my body. It helps me calm down and it helps me tune my mind and instead of being overamping I'm calmer.

Medusa deliberately evokes a state of calmness before he jumps via a routine that generates both an internal and environmental focus. All pilots reiterated that the process of seamlessly connecting with both the self and the environment is developed over time, as the following accounts illustrate:

> I center my body and mind. I think it is something that takes time to learn. You need to be at one with yourself and [to] put all your energy into the one moment of leaping off the object, this way you are in tune 100% with your surroundings and yourself and the present moment. (Christopher)

> The most important thing for me personally is to not jump until I've calmed all my nerves. And [I] found a way to get my heartbeat to slow down to normal, by breathing deep, have that kind of feeling of Zen and not be rushed into a moment of jumping before you're ready. That's probably the most important part, [to] have your mind in the right place before you exit. (. . .) I go from a point of nervous, where it feels like a pinball in my head, it's bouncing around and there's a lot of nerves and I'm excited and I feel the adrenaline, to eventually through breathing I get to a point of just a calm. (. . .) It's not nervousness and excited, you've finally found a way to change that into what almost feels happy and warm. Like a place of peace. (Bumblebee)

In summary, all pilots identified three instrumental aspects of present-moment awareness. First, being fully in the present was vital for execution. Second, present-moment awareness is simultaneously an internal focus and an attunement with the environment. Third, present-moment awareness is deliberately cultivated as a key aspect of flying optimally. This kind of 'pre-flight practice,' as described by participants above, does not seem to be a replication of the traditional pre-performance routines (Cotterill, 2010, 2011; Cotterill et al., 2010; Yancey et al., 2011) and arousal reduction techniques (Thelwell et al., 2006; Guillot and Collet, 2008; Gucciardi et al., 2010) encouraged in conventional sporting practice. While this pre-flight practice brings the pilots to the desired mental and physical state for optimal execution, it appears to be a notably different kind of experience, at times drawing elements of the dominant performance narrative, but more often following the contours of the less frequently heard (in sport) discovery narrative.

DISCUSSION

This paper aimed to elaborate on the psychological practices proximity wingsuit pilots employ to perform effectively and to reduce the likelihood of serious mishaps through taking seriously

pilots' stories of their lived experience. A surprising finding is that the form of pilots' stories deviate in fundamental ways from the dominant performance narrative in sport where the overriding focus is on achieving performance outcomes (see Douglas and Carless, 2006, 2015). Instead, these pilots' stories follow more closely the contours of the discovery narrative type (see Douglas and Carless, 2006, 2015). This distinction is significant as the wingsuit pilots in this study are achieving high-level or elite performance *without* adopting or subscribing to the values of the culturally dominant narrative type in elite sport. By exhibiting instead the plot of the discovery narrative, their stories map another way to *be effective* at the elite level. This finding contributes to and extends existing narrative research in elite sport and suggests that further research into the experiences of extreme sport participants has the potential to contribute valuable new insights to the field of sport psychology.

Perhaps central to the performance/discovery distinction we have identified is how, for these elite wingsuit pilots, success (such as executing effective jumps) is less about achieving performance outcomes (such as winning or being the best), and more about living to fly another day. As one participant put it, "In a sport like ours it's a question of survival." Jenkins (2013) notes the prevalence of battle or war metaphors in sports stories which, according to Douglas and Carless (2015), serve to raise the stakes of sporting contests, portraying winning as a matter of life or death. They observe how, "in war stories, winning is survival while losing is death," while "in sport whether or not a team or individual wins or loses is *not* a matter of life or death" (Douglas and Carless, 2015, p. 13). The perspective for these wingsuit pilots, however, is that a poor outcome can and does result in death. We propose that this core existential contrast (between sports in which participants do not typically risk death and winsguit flying where they do) *calls for*, *supports* and perhaps even *requires* participants to narrate their lives in ways that are at odds with the dominant narrative within sport.

According to the wingsuit pilots in this study, on any given day the active stage of flying is about knowing, accepting and regulating the relationships between individual features, task features, and environmental features. This balanced co-existence of awareness, acceptance, and regulation led us to choose the expression *leave your ego at the door* to encapsulate a way of being and doing that these participants narrated and endorsed. Critical to this phrase, are the four themes of knowing self, skills, environment and taming one's 'inner animal.' On the basis of participants' accounts, a wingsuit pilot would not be able to 'leave his ego at the cliff's door' if all these other types and levels of awareness were absent.

In contrast to current research on self-awareness in extreme sports which suggest that extreme sport athletes deliberately avoid any attempt to be self-aware (Castanier et al., 2010) proximity pilots in this study went to great lengths to stress the importance of self-knowledge. Self-awareness is viewed as an essential element of successful flying. To an extent, the pilots in this study described psychological elements that mirror Vealey's (2007) model of mental skills which emerged based on traditional sports, in that they emphasized the importance of developing self-awareness over time, tuning into the present moment just before the activity, and the continual process of attunement while flying. However, the pilots in this study emphasized the importance of a dynamic person-environment interaction and value-guided action (to walk away and try again at another time) over any effort to avoid or attempt to change the uncomfortable present-moment awareness associated with not being ready for a particular jump (either because of present moment conditions or their skill level). This continuous dynamic person-environment interaction and value-guided action takes the wingsuit performers many steps away from the traditional elite sport unconditional competition for the survival of the fittest. Further, they emphasized the importance of performing well within personal capabilities in order to avoid tempting death.

In the introduction we suggested that understanding the experience of effective performance in extreme sports could help inform extreme sport athletes and perhaps even add to traditional sports. Findings from this study suggest that effective extreme sports participation is not about innate abilities, who can take the biggest risk or who can demonstrate the most macho line. Athletes interested in extreme sports ought to spend time cultivating self-knowledge and guiding values before taking part. Rather than pushing the limits, effective participation is dependent on honest continual self-evaluation and the courage to walk away and participate well within personal capabilities. While majority of traditional sports do not usually involve experiences that might end in death there are still some learnings that might be of use. Considering that the interviewed pilots' pre-flight practice brings them to an optimal mental and physical state (e.g., focused, absence of heightened pre-execution anxiety) that leads to effective jump execution, traditional performing might be also effective if guided by deep values and close connection with 'thy self.' Moreover and in view of recent death cases post athletic retirement, traditional athletes' lives (during and after sports) might be more prosperous if winning and traditional way of being and doing for elite achievement were put into a different perspective (not the ultimate and only goal), one cultivated by meaning and purpose.

CONCLUSION

Self-knowledge, the ability to tune into the environment and the courage to walk away are clearly important elements for the safe and optimal execution of proximity flying. Pilots in this study highlighted the importance of values, of a proactive process of tuning into the self and environment before flying and of an ongoing process during flight, the ultimate aim being to live to fly another day. Findings from this study suggest that far from avoiding self-awareness, self-awareness is vital for effective participation. Successful proximity flying does not seem to depend on an innate ability but the cultivation of meaning and purpose supported by values that reach beyond the activity and stretch into life. Effective participation – and long-term one – is dependent on the development of profound knowledge of the

relationship between self, task and the environment. In these ways, we suggest that wingsuit pilots' stories of their experiences differ markedly from the dominant performance narrative in sport. Instead, the more closely resemble the discovery narrative type, scripting an alternative way of storying, navigating and living life as an elite performer.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of University of Thessaly's Ethics Committee with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the 'name of committee.'

AUTHOR CONTRIBUTIONS

CA lead the project, gathered the data and was instrumental in developing the article, the topic area and interpreting the data. EB was instrumental in developing the article, the topic area and interpreting the data. SC was instrumental in developing the article, and interpreting the data. DC is a narrative specialist and was instrumental in interpreting the data from a narrative perspective.

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Development and Initial Validation of a Rock Climbing Craving Questionnaire (RCCQ)

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Conceptual similarities have been identified between experiences of extreme sports athletes and those with drug and behavioral addictions. Evidence suggests rock climbers experience craving and other withdrawal-like states when abstinent from their sport. However, no studies have attempted to quantitatively measure the craving experienced by participants of any extreme sports. Such a measure could allow a greater understanding of the craving experienced by extreme sports athletes and a comparison of these across sports (e.g., surfing) and activities (e.g., drug-use). Therefore, using validated craving measures as a template, the aim of the two studies outlined here was to design and preliminarily validate a subjective multidimensional inventory that could be used to measure craving in the sports of rock-climbing and mountaineering ("RCCQ"). The aim of the first study was to investigate the factor structure of a preliminary measure of craving. Climbers (n = 407) completed the RCCQ. A 3-factor model explained 53.65% of the total variance in item scores. All three factors comprised five items each, which were conceptually labeled as "urge to climb" "negative reinforcement" and "positive reinforcement." The aim of the second study was to validate the 15-item 3-factor RCCQ resulting from Study 1 using confirmatory factor analysis (CFA). Climbers (n = 254) completed the questionnaire under a climbing-related cue condition or a cue-neutral condition. CFA revealed a good model fit and that all individual parameter estimates were significant and standard errors were within reasonable limits once item 13 was removed from Factor 1. Study 1 supports the multi-dimensional nature of rock climbing craving and shows parallels with substance-related craving in reflecting intention and positive (desire) and negative (withdrawal) reinforcement. Study 2 confirms this factor structure and gives initial validation to the measure with evidence that these factors are sensitive to cue exposure. Given the preliminary nature of the data, any practical implications are tentative. However, if as shown here, craving for climbing (and potentially other extreme sports) is similar to that experienced by drug-users and addicts, there is the potential that climbing and other extreme sports could be used as a replacement therapy for drug users.

Keywords: extreme sport, climbing, craving, reinforcement, withdrawal

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INTRODUCTION

A number of conceptual similarities have been identified between the psychological and behavioral experiences of extreme sports athletes and those with drug and behavioral addictions. Buckley (2015) recently provided a systematic exposition of the similarities between the two populations based on >30,000 hours of ethnographic observation and 160 interviews with extreme sports athletes, arguing parallels between the preoccupation with and prioritization of the activity, mood modification and emotional reward seeking, the development of tolerance and the experience of withdrawal symptoms. Buckley's comparisons are corroborated by extant studies of extreme sports athletes' experiences. For example, Franken et al. (2006) found that during periods of abstinence skydivers experienced anhedonia, a negative mood state often observed in withdrawing drug-users. Strong cravings or urges for participation have also been observed in skydivers (Price and Bundesen, 2005) and, more recently, Heirene et al. (2016) found evidence to suggest rock climbers also experience withdrawal states when abstinent from their sport. When not climbing, the participants reported urges or cravings for their sport, negative affective experiences and anhedonic symptoms.

While drug-users and extreme sports exponents may experience similar psychological states, their behaviors are distinguished on the grounds of legality, social acceptance and arguably health promotion. Thus, the impact of excessive engagement in extreme sports may be of less detriment to a person's personal, social and professional life compared with excessive drug-use. Indeed, caution must be taken to avoid pathologizing all avid extreme sports athletes as "addicts" who must be treated (cf., Billieux et al., 2015). Extreme sports provide a socially acceptable medium through which individuals can exercise, develop skills, satisfy sensation seeking traits (Diehm and Armatas, 2004), become an agent of their emotions (Woodman et al., 2010), and experience freedom (Brymer and Schweitzer, 2013), challenge, and new environments (Kerr and Mackenzie, 2012). Nonetheless, the positive outcomes associated with extreme sports participation do not reduce the validity of the observed parallels between extreme sports athletes and drug-users, rather they imply the similarities may have valuable implications for the study and treatment of addiction.

If avid extreme sports athletes are addicted to some degree, they may provide an easily accessible and potentially willing population for the study of addiction (Buckley, 2015). Further research is also warranted on the study of extreme sports addiction and its similarities with substance addictions, given the recent impetus for using extreme sports as an intervention for mental health problems (Luttenberger et al., 2015; Clough et al., 2016). However, currently no measures of addiction or allied constructs have been developed and validated for use with extreme sports athletes, restricting its study within this population. Consequently, in the present study we aimed to develop and validate a craving measure applicable to extreme sports athletes, given the central role played by craving in drug-addiction maintenance and relapse (Tiffany and Wray, 2012). Craving was also central to rock climbers' experiences in Heirene et al. (2016), where it was conceptualized as a strong, overarching need to participate, with reports of urges and compulsions comparable to that observed in those with an addiction. Such a measure could allow a greater understanding of the degree of craving experienced by extreme sports athletes and a comparison of these across sports (e.g., surfing) and activities (e.g., drug-use), as well as a greater understanding of the association between the degree of craving and other states (e.g., withdrawal symptoms) and behaviors (e.g., over training, excessive risk-taking).

In the psychopharmacological literature craving is defined as a subjective motivational state in which an individual experiences an intense desire to engage in drug-taking (UNDCP and WHO, 1992). Craving is believed to be "at the heart" of addiction and factors including abstinence (Tiffany, 1990), mood states (Shen et al., 2012) and cue-exposure (Kreusch et al., 2017) are known to mediate drug-craving. A number of conceptual similarities between the craving experienced by drug users and that by extreme sports athletes have been identified. For example, rock climbers in Heirene et al.'s (2016) study suggested exposure to climbing related stimuli increased their craving. Additionally, both rock climbers in Heirene et al. (2016) and skydivers in Price and Bundesen (2005) suggested their urges were often underpinned by a motive to remove negative psychological states or "self-medicate."

To date, craving has predominantly been measured using the original multidimensional Questionnaire of Smoking Urges (QSU; Tiffany and Drobes, 1991) and its many derivatives applied to other substances, including alcohol (Clark, 1994; Singleton et al., 2004) cocaine (Tiffany et al., 1993), amphetamine (James et al., 2004), and caffeine (West and Roderique-Davies, 2007). The original questionnaire consisted of 32 items and 2 factors, labeled as positive reinforcement and negative reinforcement. However, since then, the other derivatives of the QSU have found that three factors best fit the data. For example, during the development of the Alcohol Craving Questionnaire (ACQ; Singleton et al., 2004) and the Desires for Alcohol Questionnaire (DAQ; Clark, 1994), both sets of authors found a third factor representing "No desire to drink" and "Mild desires and intentions," respectively.

No studies have yet attempted to quantitatively measure the craving experienced by participants of extreme sports. Consequently, there are no validated measures suitable for this purpose. Therefore, using the original QSU as a template, the aim of the two studies outlined here was to design and preliminarily validate a subjective multidimensional inventory which could be used to measure craving in the sports of rock-climbing and mountaineering. Rock-climbers and mountaineers were sampled for several reasons. First, findings from Heirene et al. (2016) study suggest climbers of different ability levels experience craving for their sport. Second, they represent 'true' extreme sports, where serious mistakes of judgment can have serious consequences (i.e., severe injury or death). Finally, within the United Kingdom, rock climbing and mountaineering have both high participation

rates and broad appeal compared to other niche extreme sports (e.g., BASE-jumping). For example, UKclimbing.com, the most popular climbing website and forum in the United Kingdom, has over 48,000 users ranging in age from under 21 to over 50, providing a rich source of data.

STUDY 1

The aim of the first study was to investigate the factor structure of a preliminary measure of extreme sports craving using an adapted version of the original 32 item QSU. Although current trends suggest the use of confirmatory factor analysis (CFA) is preferable for testing hypotheses about the structure of latent variables (Biddle et al., 2001), given the novel and exploratory nature of the research, and the precedent in analysis methods used by previous derivatives of the QSU (e.g., James et al., 2004), it was deemed appropriate in this instance to use exploratory factor analysis as a first stage (Field, 2013, p. 666). Therefore, while it was expected that the data would be similar to recent versions of the QSU (e.g., West and Roderique-Davies, 2007), no specific hypotheses were made about the factor structure.

Questionnaire Development

We based the Rock Climbing Craving Questionnaire (RCCQ) on previously validated, substance-specific, multi-dimensional craving questionnaires that utilized the Questionnaire of Smoking Urges (QSU, Tiffany and Drobes, 1991) as their foundation (see Davies et al., 2000, Cigarettes; James et al., 2004, Amphetamines; Love et al., 1998, Alcohol; Tiffany et al., 1993, Cocaine; West and Roderique-Davies, 2007, Caffeine). Each of these questionnaires conceptualizes "craving" in terms of relief of withdrawal or negative affect, desires and intentions, and anticipation of positive outcomes. Initially, the 38 items from the most recent of these questionnaires (caffeine craving questionnaire; West and Roderique-Davies, 2007) were transformed into climbing relevant items, such that the word "climbing" replaced "caffeine" where appropriate. In addition, some items were changed from the passive sense (e.g., *to have some caffeine*) to the active sense (e.g., *to go climbing*). Three items from the Caffeine Craving Questionnaire were inappropriate in this context (e.g., *I would feel more nauseous if I was having caffeine*) and were removed leaving 35 items.

A preliminary version of the RCCQ was subjected to peer-appraisal and administered to 10 volunteers. This suggested sufficient levels of congruence between the researchers' and participants' meaning of each item. Each item was presented on a separate page, which required a response before answering the next item. Participants were asked to report their level of agreement with each statement by responding on a Likert-type scale to each item, anchored by 1 (*strongly disagree*) and 7 (*strongly agree*; Tiffany and Drobes, 1991), with 12 of the items being reverse-keyed.

Participants

A total of 407 individuals (mean age: 35.37, *SD*: 13.75, 326 male, 81 female) completed the RCCQ. Climbers from 20 different countries across five continents participated, and a variety of primary climbing disciplines were reported, comprising traditional climbing (n = 175; 43%), indoor climbing (n = 100; 24.6%), sport climbing (n = 70; 17.2%), bouldering (n = 49; 12%), alpine climbing (n = 10; 2.5%), mixed climbing (n = 2; 0.5%) and ice climbing (n = 1; 0.2%). A prerequisite to participation was that all climbers had a minimum of 6 months of climbing experience. The length of participants' climbing experience varied, with 29 having 6 months to 1 year's experience, 91 having 1–3 years, 75 3–6 years, 43 6–9 years, 28 9–12 years and 141 with more than 12 years' experience. Frequency of climbing varied from 3 or more times per week to at least once per year, with most stating they climbed at least once a week (n = 178) or 3 or more times per week (n = 134). The length of time since participants' last climb varied from less than 1 day to 400 days, with a mode of 1 day. Climbing ability varied significantly, from novice (best worked grade: traditional climbing: VS, sport climbing: Fr5) to elite level (best worked grade: traditional climbing: E9 7a, sport climbing: Fr8b; bouldering: V9).

Procedures

Two forms of participant recruitment and data collection were implemented. In one method, rock climbers and mountaineers were recruited from two-UK-Based internet climbing forums. Specifically, a premier post (a forum posting which remains at the top of the page) was purchased which outlined the details of the study and asked users to participate. Participants completed the questionnaire on-line via Surveymonkey. To control for multiple submissions each respondent's IP address was logged and subsequently blocked following questionnaire completion. In the second method, participants were sampled from indoor climbing gyms in South Wales. Participants recruited via this method completed the survey in paper format or online using a laptop provided by the research team.

Ethics Statement

Ethics approval was sought from the first author's School Ethics Committee prior to commencing both studies. This study was carried out in accordance with the recommendations of BPS code of Human Research Ethics with written informed consent from all participants. All participants gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the University of South Wales School of Psychology and Therapeutic Studies Ethics subcommittee.

Statistical Analysis

Of the original 407 cases only 368 cases were included in the principal component analysis as cases with missing values were deleted listwise. Responses to reverse-keyed items were inverted before the main analysis. Data was pre-screened for multicollinearity by examining inter-item correlations for values above r = 0.9; none were observed. Kaiser-Meyer-Olgin measure of sampling adequacy was 0.93 indicating the sample size was large enough and Bartlett's test of sphericity was significant ($p < 0.001$) indicating the original correlation matrix was an identity matrix as required. Principal component analysis was performed using the oblique (Oblimin) method (Hendrickson

and White, 1964) as this was expected to produce the 'cleanest' factors (Love et al., 1998; James et al., 2004). The initial PCA requested was 'unforced,' with subsequent iterations 'forced' in order to identify the most parsimonious model. In the initial unforced PCA only factors with eigenvalues greater than one were retained and subjected to scrutiny regarding their item content (Tiffany and Drobes, 1991; Davies et al., 2000; James et al., 2004). Items were considered meaningful only if they loaded at higher than 0.4 on a given factor, and that this loading was at least 0.2 greater the item's next highest loading on another factor (Tiffany and Drobes, 1991; Davies et al., 2000; James et al., 2004). For the forced PCA that followed, eigenvalue criteria were moot, however, the method for scrutinizing items was the same.

Results

The first iteration of the PCA whereby all items were free to load onto any number of factors resulted in a 5-factor model, with Eigenvalues of 14.55, 2.36, 1.87, 1.35, and 1.13. The total variance explained by this model was 60.71%, with variance values for each Factor (1–5) of 41.57, 6.70, 5.36, 3.86, and 3.21. Factor loading for each item revealed that Factor 1 contained seven items, Factor 2 contained six items, Factor 3 contained five items, Factor 4 contained four items and Factor 5 contained only two items. Although item loadings made conceptual sense (conceptual labels of "positive reinforcement," "negative reinforcement," "mood and well-being," "temporal plans," and "extreme events" were applied in order) a decision was made to test a four-factor model due to the small number of items within the 5th factor.

The four-factor model explained a total 57.5% of the variance, with variance values for each Factor (1–4) of, 41.58, 6.70, 5.36, and 3.86. Factor loading for each item revealed that Factors 1 and 2 contained six items each, Factor 3 contained three items, and Factor 4 contained two items. As before, loading made some conceptual sense, however, Factors 2 and 3 seemed to both measure negative reinforcement, while the two items for Factor 4 (labeled "urge to climb") were insufficient for a reasonable measure of internal reliability. Therefore, the decision was made to force one final model that contained only three factors.

The three-factor model explained a total of 53.65% of the total variance in item scores, with values for each Factors (1–3) of 41.57, 6.70, and 5.36. All three factors comprised five items each, which were conceptually labeled as "urge to climb," "negative reinforcement," and "positive reinforcement" (**Table 1**). Even though this model explained the least amount of variance of the three models tested here, the model appeared to have the strongest face validity, made conceptual sense, had an equal balance of items per factor and was the most parsimonious model tested. Therefore, the decision was made to use this model as the basis for the next stage of the scale validation.

STUDY 2

The primary aim of the second study was to validate the 15 item 3 factor RCCQ resulting from Study 1 using CFA. The secondary aim was to investigate predictive validity of the RCCQ to two factors known to influence acute craving: abstinence and climbing-related cue exposure.

Participants

In total, 254 climbers (mean age: 31.6, *SD*: 10.1, 209 male, 70 female) took part in the study. While a second process of data collection was implemented for this study following the analysis of findings from Study 1, it is possible that some of the climbers who took part in the first study also participated in Study 2. The same participant recruitment and data collection methods used for Study 1 were replicated for this study, with one exception. Approximately half the participant (n = 125) completed the questionnaire while being simultaneously presented with climbing related cues in the form of visual media depicting either climbing itself or climbing related equipment (e.g., a rope and harness). A new picture was presented next to each question in the craving measure as the online survey was completed. Similar variance to the first study's sample was observed in participants' climbing discipline, duration, frequency, days since last time and ability.

Statistical Analysis

Confirmatory factor analysis using EQS 6.01 software (Bentler, 2005) was used to assess the fit of the data from this new sample to the proposed 15-item scale identified by the PCA in Study 1. First, data was screened for multivariate normality using Mardia's (1970, 1974). Normalized Coefficient whereby values greater than 5 indicated non-normal data (Bentler, 2005). In this instance Mardia's normalized value was 17.73 and therefore all CFA models were run using the ROBUST statistic method available in the EQS software, which runs the Satorra–Bentler Chi Square (S–B χ^2: Satorra and Bentler, 1994) and calculates robust standard errors (Bentler and Dijkstra, 1985). The Maximum Likelihood (ML) estimation process was employed as research has indicated that parameter estimates remain valid even when the data are non-normal (Satorra and Bentler, 1994).

Confirmatory factor analysis models were assessed both in terms of overall model fit and for each individual parameter estimate. Fit indices were chosen to indicate model fit, model comparison, and model parsimony and included Root Mean Square Error of Approximation (RMSEA: Steiger and Lind, 1980), the Comparative Fit index (CFI: Bentler and Bonett, 1980), the Non-Normed Fit Index (NNFI: Tucker and Lewis, 1973) and the McDonald Fit Index (MFI: McDonald, 1989). The criterion scores used to indicate a good fit to the proposed model were: $<$0.06 for RMSEA, $>$0.90–0.95 for CFI and NNFI, and $>$0.89 for the MFI (Hu and Bentler, 1999). Lagrange Multiplier tests (LM χ^2) were used to test the viability of specific parameters in the proposed model (Byrne, 2008), where a significant LM χ^2 indicates factor cross loadings, error covariance, and consequently model misspecification. Misspecification is indicated when a parameter set shows incremental univariate χ^2 values substantially greater than the other parameter sets (see Byrne, 2008, p. 111). This information can then be used to guide further specification searches before finalizing the model.

TABLE 1 | Rock climbing craving questionnaire (RCCQ) items factor loadings.

	Factor loading		
RCCQ Item	**Factor 1**	**Factor 2**	**Factor 3**
Factor 1 – Urge to climb	0.679		
5. I will go climbing as soon as I get the chance	0.532		
10. Starting now, I could go without climbing for a long time	0.802		
13. All I want to do right now is go climbing	0.759		
24. I am going to go climbing as soon as possible	0.479		
31. Right now, I am not making any plans to go climbing	0.679		
Factor 2 – Negative reinforcement		0.727	
7. Climbing would make me less depressed		0.633	
8. Climbing would not help me calm down		0.808	
23. My head would be clearer right now if I could go climbing		0.784	
28. If I were climbing now, I could think more clearly		0.781	
32. It would feel as if the bad things in my life had completely disappeared if I went climbing now		0.727	
Factor 3 – Positive reinforcement			0.663
1. Climbing would make me feel very good right now			0.604
11. Going climbing would not be pleasant			0.653
14. Climbing right now would invigorate me			0.752
21. I would not enjoy climbing right now			0.677
26. Going climbing would not be very satisfying now			0.663

ANCOVA and MANCOVA was used, respectively, to examine the difference in total craving scores and each of the three craving factors between those who completed the questionnaire while viewing climbing related cues and those who did not. The covariates of 'climbing frequency,' 'day since last climb,' and 'total climbing experience' were added to both models. For the MANCOVA a follow-up principal component analysis was used to examine the nature of significant differences between the two conditions (Field, 2013). Finally, four separate simple regressions were performed to examine whether the number of days since participants last climbed predicted either total craving scores or those of the three underlying factors.

Results

For the first CFA model tested, examination of standardized residuals indicated the average absolute standardized residual was 0.044, whereas the off-diagonal absolute standardized residual was 0.050. Furthermore, 91.67% of all standardized residual fell between −0.1 and 0.1, with a further 7.50% occurring between 0.1 and 0.2, indicating a good fit to the model overall. Fit Statistics (S–B χ^2 = 162.86, $p < 0.01$, RMSEA = 0.056 [CI 0.042 −0.069], CFI = 0.927, NNFI = 0.911, MFI = 0.873) indicated an adequate fit to the hypothesized model. Review of unstandardized individual parameter estimates indicated all individual parameter estimates were significant and that standard errors were within reasonable limits (Jöreskog and Sörborm, 1989). Multivariate LM χ^2 test indicated one parameter (χ^2 = 23.52, $p < 0.01$) that would potentially lead to improvements in model specification if it were freely estimated. Specifically, question 13 ("All I want to do right now is go climbing") which was originally fixed to Factor 1 (urge to climb) might improve the model if it was removed.

The second CFA examined the same model except question 13 was removed as an item from Factor 1(Urge to climb). Overall the model indicated an improved fit. Examination of standardized residuals indicated that the average absolute standardized residual was 0.037, whereas the off-diagonal absolute standardized residual was 0.043. Furthermore, 99.99% of all standardized residual fell between −0.2 and 0.2. Satorra–Bentler Chi-Squared was substantially improved from the previous model (S–B χ^2 = 113.68, $p < 0.01$), as were the fit indices (RMSEA = 0.044 [CI 0.027 −0.059], CFI = 0.956, NNFI = 0.946, MFI = 0.931). As with the previous model, unstandardized individual parameter estimates indicated that all individual parameter estimates were significant and that standard errors were within reasonable limits.

After controlling for all three covariates, the ANCOVA revealed a significant increase in total craving scores in participants who completed the questionnaire in the presence of climbing related cues [$F(1,249) = 9.70$, $p = 0.002$, $\eta_p^2 = 0.04$]. However, individually none of the covariates were significantly related to total craving scores ($p > 0.05$). A MANCOVA indicated a significant overall difference across all three sub-factors when taking into account the effects of the three covariates [$F(3,247) = 4.421$, $p = 0.005$, $\eta_p^2 = 0.051$]. Of the three covariates, only 'frequency of climbing' was significantly related to the three measures of craving scores [$F(3,274) = 5.07$, $p = 0.002$, $\eta_p^2 = 0.058$] with Beta values indicating that as climbing frequency increased, so too did craving via negative ($B = 0.71$, $p = 0.01$) and positive ($B = 0.21$, $p = 0.47$) reinforcement. In contrast, as frequency increased, a significant reduction in "urge to climb" was observed ($B = -0.09$, $p = 0.01$). Follow up principal component analysis indicated one discriminant function that

TABLE 2 | Total RCCQ craving score and mean factor scores by cue condition.

	Cue condition	*M*	*SD*	Cohen's *d*
Total craving	No image	57.06	6.10	
	Image	59.58	6.83	0.39
Negative reinforcement	No image	3.2915	0.57064	
	Image	3.5664	0.70103	0.42
Urge to climb	No image	4.0659	0.60315	
	Image	4.196	0.5242	0.24
Positive reinforcement	No image	4.2744	0.47108	
	Image	4.3568	0.42622	0.18

explained 100% of the variance (Canonical $R^2 = 0.05$). This function significantly differentiated between groups (image vs. no image) [$\Lambda = 0.945$, $\chi^2(3) = 14.78$, $p = 0.002$] with canonical correlation coefficients (negative reinforcement, $r = 0.931$; urge, $r = 0.51$; positive, $r = 0.302$) indicating negative reinforcement contributed the most to separation between those who completed the questionnaire in the presence of images and those who did not (Bray and Maxwell, 1985). Follow up calculations of Cohen's *d* effect sizes between the image and no image conditions indicated a small to medium effect size for total craving and negative reinforcement, and a small effect size for 'urge to climb,' and 'positive reinforcement' (Cohen, 1988). See **Table 2**.

Simple regressions for each sub-factor and overall craving indicated that 'number of days since last climbed' explained 17% ($\beta = -0.02$, $p = 0.07$), 4% ($\beta = -0.004$, $p < 0.01$), <1% ($\beta = -0.002$, $p = 0.92$), and <1% ($\beta = -0.001$, $p = 0.17$) for total craving, 'urge to climb,' 'negative reinforcement,' and 'positive reinforcement,' respectively. Beta values were only significant for 'urge to climb,' but negative beta values for all dependents indicated that craving scores generally decreased the longer the absence.

OVERALL DISCUSSION

The aim of the studies presented here, was to develop a tool for measuring the state of craving that has previously been identified in rock climbers and mountaineers (Heirene et al., 2016), with the aim of better understanding and quantifying this state. In a two-study development and validation process, support was provided for the factor structure and predictive validity of the Rock Climbing Craving Questionnaire. Specifically, factor analysis revealed a three-factor structure consisting of (*1*) *Urge to climb*, (*2*) *Negative reinforcement*, and (*3*) *Positive reinforcement*. Factor 1 consisted of items reflecting intention to go climbing in the near future and may be considered reminiscent of an urge or craving to go climbing. Factor 2 consisted of items reflecting relief from the negative consequences of not climbing and may be considered reminiscent of climbing-related withdrawal symptoms. Factor 3 consisted of items reflecting a beneficial effect of going climbing and may be considered reminiscent of anticipating an experiential high from going climbing. These factors are comparable to those found in other derivatives of the QSU (e.g., Davies et al., 2000; James et al., 2004; West and Roderique-Davies, 2007) representing desire and intention, positive reinforcement and negative reinforcement. Study 2 confirmed this factor structure.

Given that no other climbing craving questionnaires exist, it was not possible to directly measure construct validity. Instead, we tested the predictive validity (the ability to predict predefined relationships with other variables) of the scale by presenting the questionnaire with and without cues (i.e., climbing related photos) and investigating the relationship between days since last climb (abstinence) and scores on the questionnaire. The craving literature predicts that scores for craving would be higher in the presence of cues and should increase with days since last climb (*see* Roderique-Davies, 2008). The results revealed that for all three factors there were small to medium effect size increases in craving in the presence of climbing-related cues. This matches previous drug/pharmacological research which has shown the presence of relevant cues increases an individual's craving (e.g., Davies et al., 2000; Goldstein et al., 2009; Schiffer et al., 2009). The highest effect size was observed in the Negative Reinforcement Factor. This is consistent with the findings of Heirene et al. (2016) who reported that rock-climbing athletes appear to experience withdrawal symptoms comparable to individuals with substance and behavioral addictions.

When compared to previous drug research (e.g., McClernon et al., 2009) the lack of positive relationships between time since last climb and craving scores is surprising. Even though the participants in this instance were not drug users, the evidence from extreme sport participants would indicate that abstinence does increase craving (Heirene et al., 2016). West and Roderique-Davies (2007) found a similar relationship between abstinence and craving when they validated the Caffeine Craving Questionnaire. They suggested that as abstinence was not enforced, and participants simply completed the questionnaire without altering their caffeine usage patterns, this abstinence was unlikely to predict craving. In our study, the same is true; although participants displayed a range of abstinence patterning, this abstinence was neither requested nor enforced. From a cognitive-behavioral perspective, individuals who feel they are in control (i.e., have a choice to climb or not) are less likely to experience emotional disturbance (Neenan and Dryden, 2000). Craving is likely to be greatest therefore when individuals are forced to abstain for a period of time and maintain an intention to partake in the activity they crave (e.g., Voglewede and Noel, 2003). However, caution should be taken with this as further studies are needed to clarify the role of abstinence in this context.

Study Limitations

The present study may be limited by the heterogeneous participant sample, which comprised climbers and mountaineers with multiple primary climbing disciplines, including indoor climbing, outdoor traditional climbing, alpine climbing and ice climbing. Indoor climbing differs considerably from alpine and other outdoor climbing not only in setting, but also in level

of risk. Thus, the type and degree of craving could also differ considerably between these sub-disciplines. Additionally, the inclusion of climbers with multiple primary disciplines may have influenced the degree to which the climbing-related cues presented during Study 2 affected craving levels, as these were not tailored to each person's specific climbing discipline. Future research may wish to recruit climbers of only one primary climbing activity or compare between disciplines in order to better understand how this affects craving and other features of addiction.

Practical Implications and Directions for Future Research

At this stage, given the preliminary nature of the data, any practical implications are tentative. However, if as shown here, craving for climbing (and potentially other extreme sports) is similar to that experienced by drug-users and addicts, there is the potential climbing and other extreme sports could be used as a replacement therapy for drug users. Specifically, in contrast to drug use, climbing is a socially acceptable activity. Therefore, it is possible that craving experienced by drug users might be lessened/replaced if users are encouraged to participate in climbing activities (or possibly other extreme sports). While to date there is little evidence as to the mechanisms by which these interventions might work, Clough et al. (2016) have recently highlighted several factors associated with adventure sports which may serve as therapeutic components if used as an intervention for mental health issues. These include physical activity as a tool for improving both physical and psychological health; physical and psychological challenge as a method of enhancing mental toughness; and environmental exposure as a means of engendering a sense of well-being and connection with natural environments. More broadly, both traditional sports and exercise routines have shown promise as interventions for drug-addiction, with suggestions that exercise may attenuate craving states and reduce relapse through interactions with the neurotransmitters active in neural reward pathways, including dopamine and glutamate (Lynch et al., 2013). Though, whether the unique characteristics of extreme sports make them more suitable candidates for addiction therapy – as Clough et al. (2016) suggestions would indicate – remains unknown. Thus, the use of extreme sports as an intervention for problematic substance use requires further investigation in order to better understand the potential role these sports could play in a therapeutic context.

It would be of value to investigate the presence of craving in non-extreme sports. To date, investigations of sport-related withdrawal symptoms have been mostly confined to athletes of extreme sports, in line with the popular media conception of such athletes as "adrenaline addicts." The motivation for developing a measure of extreme sports craving here, as opposed to a more general 'sports craving' measure, was underpinned by these studies which have identified conceptual and phenomenological similarities between the experiences of extreme sports athletes and those with an addiction (e.g., Heirene et al., 2016). Nonetheless, it is necessary to determine whether the type of craving measured here is a unique consequence of the 'extreme' properties of climbing and similar sports, or can be induced by participation in any sport or physical activity. Indeed, exercise addiction has been proposed as a discrete nosological entity (Berczik et al., 2012) and identified to some degree in multiple populations (e.g., Lichtenstein et al., 2014), suggesting a comparable craving state may be experienced; though investigations of sport-specific addiction appear scant.

The craving measure developed here may be useful in its direct application for understanding the experience of rock climbers and mountaineers. For example, the RCCQ could be used to explore associations between craving levels and subsequent behaviors such as excessive risk-taking or over-training, allowing athletes and coaches an opportunity to identify at-risk individuals. Use of the RCCQ will also allow a greater understanding of extreme sports craving, allowing comparisons of craving levels between sports (both alternative extreme sports and traditional sports) or activities (e.g., drug use) and further investigations of the factors influencing craving levels. Collecting RCCQ scores and physiological data in combination will also enhance the understanding of the physical experiences associated with the addictive-like states observed in these athletes, providing further opportunities for comparing extreme sports craving with the craving observed in other domains such as drug-addiction.

Experimental research is also warranted to further test the predictive validity of the RCCQ model identified here. For example, given that period of abstinence showed no significant positive relationship with RCCQ scores in this study, future researchers should test the influence of forced periods of abstinence on craving scores. In individuals with self-reported exercise addictions, forced periods of abstinence have been associated with decreased mood and vigor, increased tension, anger and confusion, and increased resting heart rate (Aidman and Woollard, 2003), indicating forced abstinence in climbers may be more likely to induce craving states. In climbers and other extreme sports athletes, craving could be investigated during periods of injury in order to circumvent the need to proscribe participation. In addition, more specific research is needed on the influence of cues on craving. In particular, testing the influence of cues in a sample of climbers from only one discipline (e.g., rock-climbing), and ensuring that the cues are ecologically valid and personally meaningful (e.g., familiar locations or familiar climbers). Finally, although research has examined personality factors associated with both substance abusers and extreme sports participants (e.g., Breivik, 1996; Slanger and Rudestam, 1997; Loxton et al., 2008; Roderique-Davies and Shearer, 2010), to date these groups have been examined in isolation of one another. Therefore, research is warranted which compares both groups for both craving and personality (e.g., sensation seeking traits or impulsivity). This type of research will allow a greater understanding of how craving presents in extreme sports such as climbing.

CONCLUSION

Overall, the understanding of addiction and craving in an extreme sports setting remains in its infancy compared with the

understanding of these concepts in domains such as drug-use and gambling. Nonetheless, the ability to measure and quantify climbing craving, as possible through the RRCQ developed here, will allow a greater understanding of extreme sports craving and how this compares with other forms of craving. The preliminary results obtained here corroborate suggestions that there may be conceptual similarities between extreme sport and drug cravings, including a basis in positive and negative reinforcement and an accentuating influence of cue-exposure.

AUTHOR CONTRIBUTIONS

GR-D and DS were involved in all phases of the research, including the design, data collection, analysis, and the writing of the manuscript. RH contributed to the collection and interpretation of data, writing of the manuscript, and approving the final version. SM contributed to the interpretation of data, writing of the manuscript, and approving the final version. All authors are accountable for all aspects of the work in relation to accuracy and integrity.

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Aging Adventure Athletes Assess Achievements and Alter Aspirations to Maintain Self-Esteem

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Achievements and capabilities influence the self-esteem of skilled adventure athletes. Self-esteem affects individual mental health. Aging commonly reduces adventure capabilities. To avoid loss in self-esteem, aging adventure athletes are forced to adjust their aspirations. Here, I examine this process using participant observation, ethnographic and autoethnographic approaches. The qualitative data for this analysis are derived from 60 years' experience in outdoor adventure activities, and ∼30,000 person-hours of participant observation. I argue that individuals assess their own capabilities against a set of specific feats. For some activities, successful completion of a specific feat is known as nailing it. The selection of these feats depends on factors such as activity and geographic location, as well as individual experience and peer comparisons. I examine the detailed process using a single feat repeated over a period of decades, the bubble-line kayak run through Lava Falls on the Grand Canyon of the Colorado River. I compare other examples of nail or fail to construct a general framework for self-esteem in aging adventure athletes, with both physical and psychological feedback loops. I also identify two key thresholds, as aging adventure athletes recognize their declining skills. These may apply to aging more broadly, beyond outdoor adventure.

Keywords: health, extreme, outdoor, nature, rafting, kayaking, participant, observation

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INTRODUCTION

If your self-esteem relies on your adventure abilities, what happens when you get old? I argue here that aging adventure athletes: measure their skills against past accomplishments; aim to maintain their capabilities as long as they can; are reluctant to acknowledge when they can't; and are eventually compelled to adopt a different approach to adventure, accepting that they now need assistance, but can still contribute experience. Here, I analyze these processes, using an autoethnographic approach.

Self-esteem reflects self-perceived achievements in relation to self-defined aspirations (James, 1890/1983; Eromo and Levy, 2017). Different individuals focus on achievements in different aspects of their lives, social as well as physical, and give different weights to the opinions of others (Du et al., 2017; Stephenson et al., 2017; Strandell, 2017). These differences may be mediated by gender, culture, and worldview (Chen et al., 2016; Ciccolo et al., 2016). The pursuit of self-esteem can incur costs as well as benefits (Crocker and Park, 2004).

There is an extensive academic literature on self-esteem and its role in human health (Hagger et al., 2010, 2016; Chen et al., 2017; Johnson and Rasouli, 2017). One major component of this literature relates to the links between self-esteem and aging (Orth and Robins, 2014; Orth et al., 2015; Steptoe et al., 2015; Scheidt, 2016; Wooden and Li, 2016; Wheaton, 2017). Another component addresses the links between self-esteem and professional skills (Little et al., 2015; Yu et al., 2015). In general, all professions involve acquired skills. For some professions, the emphasis is on skilled thought, ideas, and knowledge; for some, on skilled action or performance; and for many, both knowledge and skilled action are necessary.

Most professional skills eventually decline, as practitioners age (Brough et al., 2011). The age at which this decline commences, and the rate of decline, differ between professions and between individuals (Erickson et al., 2014; O'Donovan et al., 2017). In general, physical skills decline at an earlier age than mental skills (DiPietro et al., 2017). However, physical exercise can maintain mental proficiency (Leckie et al., 2012; Gomez-Pinilla and Hillman, 2013; Erickson et al., 2014; Sun et al., 2016; Harvey et al., 2017; Lee et al., 2017). With particular relevance for adventure activities, aging also affects attitudes to risk (Grubb et al., 2016).

For many expert practitioners, self-esteem and self-identity are strongly bound to skill, as assessed by self and peers. This applies both to paid professions (Little et al., 2015; Yu et al., 2015), and to voluntary leisure activities (Boyes, 2013; Hickman et al., 2016, 2017; Wheaton, 2017). Self-esteem can reflect current skills, past achievements (mastery), and future potential (talent). In judging the skill of any individual relative to their peers, one objective criterion is their ability to carry out specific feats that are internationally known and ranked. Recognized feats depend on profession, may differ between regions, and may evolve over time. They may include both (a) the successful completion of formal professional qualifications, and (b) a ranked range of feats, beyond any formal test. If skills are judged by peers through a set of feats achieved, then these feats typically increase to a peak at an age which depends on the profession, and then decrease subsequently.

The overall psychological perceptions of athletes engaged in high-risk adventure activities, also known as extreme sports, have been examined in detail (Monasterio et al., 2016; Arijs et al., 2017; Brymer and Mackenzie, 2017; Brymer and Schweitzer, 2017a,b; Holmborn et al., 2017; Immonen et al., 2017). There are few recent qualitative studies, however, that examine individual adventure athletes' perceptions of aging. There are interview-based studies of: 7 New Zealand hikers and bikers aged 63–80 (Boyes, 2013); 8 Scottish rock-climbers and 7 sea-kayakers aged 65+ (Hickman et al., 2016); 10 climbers aged 65–75 (Hickman et al., 2017); and 11 British surfers aged 45–70 (Wheaton, 2017).

MATERIALS AND METHODS

Ethics Statement

Some of the data presented here were obtained during commercial adventure tours. Assistance and sponsorship of tour operators is gratefully acknowledged. All of the research reported here, including that drawn from previous publications by the same author (Buckley, 2010, 2012, 2015a,b, 2016, 2017), as well as new research conducted specifically for the current publication, was conducted in strict compliance with the research ethics requirements of Griffith University, including adherence to the Griffith University Research Ethics Manual and the Australian National Statement on Ethical Conduct in Human Research, and approvals by the Griffith University Human Research Ethics Committee as required.

Autoethnographic Approach

I adopt a qualitative analytical autoethnographic methodology (Anderson, 2006; Tolich, 2010; Anderson and Austin, 2012; Buckley, 2012, 2015a,b, 2016; Chang, 2016; Jones et al., 2016; Pace, 2016; Stahlke Wall, 2016; Winkler, 2017). Autoethnographic approaches can yield particular accuracy, precision and subtlety in the identification of emotional responses (Buckley, 2015b, 2016; Gardner et al., 2015; Morin et al., 2015).

Autoethnographies rely on records and memories of events experienced by the analyst. Records may include photographs, videos, descriptive correspondence, and notes, journals and diaries. None of these data sources, including memory, is likely to be entirely complete or accurate (Flanagan, 1954; Brown and Kulik, 1977; Talarico and Rubin, 2003; Loftus, 2017). In the current study, however, the incidents recalled are sufficiently numerous, and extend over a long enough period, 4.5 decades, to extract robust general patterns. Memories and records may include observations (Spradley, 1980) and conversations involving other individuals. In autoethnographies, these are filtered through the perceptions of the analyst. Relevant ethical considerations and protocols are summarized by Tolich (2010).

Results are reported so that no individuals other than the author are identifiable by any mechanism, including name, role, image, geotag or other digital identifier, or place/time coordinates. This follows the autoethnographic protocols proposed by Tolich (2010). Results are also reported so that no individual incident is identifiable to a specific enterprise or sponsor. All views expressed here are those of the author, have not been discussed with any sponsors, and do not necessarily reflect the opinions of sponsor organizations or their staff.

Data Abstraction, Generalization, and Model Building

Constructing a general model for the psychological aspects of aging in adventure athletes involves multiple steps of successive abstraction. The raw data are the moment-by-moment physical and psychological details of individual adventure practice, for particular activities, at specific sites and circumstances. In particular, they include individual memories of critical incidents, specific past events that shaped individual perceptions. These memories form the lowest-tier primary data. To gain direct access to these primary data, a researcher must have been present in person at the critical incidents concerned, as protagonist or active participant.

From these moment-by-moment memories, the first level of generalization is across the events, incidents and places experienced by an individual adventure practitioner, using their memories and perceptions. That is, we can consider or enquire how individuals perceive their own psychological changes, including aging, skills, and self-esteem. These are higher-tier data than individual memories of specific critical incidents. These higher-tier data are potentially accessible through a range of different social science methodologies. Here, I adopt an autoethnographic approach, to provide particular depth and detail (Buckley, 2015b, 2016).

These higher-tier data are based on individual memories of those incidents, but they also incorporate extensive mental processing. This processing may also include other factors perceivable by the individual, such as their own physical health, and social interactions with respected peers. They may be analyzed internally by the individuals concerned, through "self-talk" or "inner speech" (Hurlburt et al., 2016; Dickens et al., 2017). Perceptions and memories may themselves be influenced by aging, and this applies in tourism and mobility research (Huber et al., 2017; Tilley et al., 2017) as well as more generally (Bradburn et al., 1987; Knäuper et al., 2016).

The second level of generalization is across the many different individual practitioners of any one adventure activity. This second level takes into account the differences in individual personalities, capabilities, expertise, experiences, age, and life history, the "leisure lifepsychle" (Buckley, 2017). The third level of generalization is across the many different adventure activities, searching for common themes and patterns as well as distinctions and differences. This third level of generalization can adopt ethnographic or autoethnographic approaches, or it could be conducted through comparisons based on published studies. Here, I adopt the former approach, since as outlined above, there are as yet too few published studies for the latter.

Data Presentation and Compression

In building a general model through successive abstractions from raw data, information is lost at each step. This occurs through two processes. The first is through the selection of specific critical incidents from a lifetime of experience for any one individual. The second is through the loss of detail during the attempt to identify patterns, the sacrifice of depth in the pursuit of breadth. There is thus a very high degree of data compression. In building a psychological model of adventure practitioners that is general enough to be connected to psychological theory, e.g., relating to aging or self-esteem, we thus discard the practical details that are of greatest interest to the adventure practitioners themselves.

In conversation between individual adventure practitioners, it is the finest detail of events and places that is of greatest interest. They will discuss, for example: the effect of a marginally different fin size or placement, on the performance of a kiteboard in wave jumping and wave riding, respectively; the effect of tiny changes in length, plan shape, and flexibility on the effort required to steer a snowboard, at speed, on steep soft powder snow, through dense trees; the changes in shape of surfable waves between incoming and outgoing tides; the effect of aspect and past snowfalls on avalanche risk on a particular morning; the exact hull angle and reverse paddle stroke needed to stand a particular model of kayak on its stern end in an eddy; and an indefinite number of similar considerations. In such discussions, they can identify technical details, where relevant, at scales down to millimeters and milliseconds.

In constructing and presenting a general model from a large volume of qualitative raw data, authors have a responsibility to convey to readers some sense of the type and extent of the raw data, and the steps in data compression. Various options are available to convey detailed qualitative data to a reader. The most commonly adopted approach is to include direct quotations from interviewees, but that is feasible only for interview data. Another approach, less common, is to construct first-person descriptive vignettes (Buckley, 2012). The approach used here is basic autobiographical description, without quotes or vignettes.

Similarly, there are standard techniques for compression of qualitative data. The most commonly used involve coding, i.e., the classification of an indefinite volume of raw data into a finite, iteratively defined set of low-level concepts; and simultaneously, iterative assembly of these concepts into a knowledge tree, a hierarchical structure of successively high-tier constructs. These approaches, however, require data compiled in, or convertible to, a text-based format, and are hence not readily applicable to the participant autoethnographic approach used here.

Here, therefore, I present data and analysis at two scales. First, I present a single subset of data, a narrow-scale perspective from a single route through a single rapid in a single whitewater kayaking river. Second, I present a broad-scale perspective, general patterns as I perceive them through an autoethnographic lens. These are derived from 60 years of outdoor adventure activities and aging, from my earliest memories to the present day. These broad scale patterns seem to me to apply widely across activities and individuals. The limitations of these approaches, however, suggest that they should perhaps best be seen as hypotheses, testable by other adventure practitioners using a range of relevant methodologies.

The narrow-scale analysis uses a single route through a rapid in a well-known multi-day white-water raft and kayak run, the Grand Canyon of the Colorado River. The rapid is Lava Falls, and the route is known as the bubble line. Data for this analysis are derived from multiple runs, by the author and other members of raft and kayak groups, over a period of several decades (Buckley, 2010). This case study aims to convey the degree of physical and psychological detail available in the raw and processed memories of adventure practitioners.

The broad-scale framework is derived from over half a century of outdoor adventure activities, both private and commercial, in several dozen different countries. The activities include: sea-kayaking and white-water kayaking; surfing, sailboarding and kiteboarding; skiing and snowboarding; and single and multi-day hiking (Buckley, 2012, 2016). Hundreds of persons and days, and tens of thousands of person-hours of ethnographic observations were involved. Information was obtained through: active participant observation; informal and formal face-to-face conversations either individually or in groups; and follow-up conversation using spoken, written, and electronic communications. As outlined above, analysis of this information

involves successive levels of abstraction: from events, to individuals, to feats, to activities, to an overall framework.

RESULTS

Nailing the Line

Expert-level practice in many skilled outdoor adventure activities involves the ability to identify, and follow, a highly specific route that allows the practitioner to pass safely and successfully through a series of obstacles. Higher levels of difficulty involve: more severe obstacles; more finely defined routes; and more rapid and precise sensory perceptions, mental analyses, and performative physical responses.

In some adventure activities, including white-water kayaking, these routes are known as lines. Sometimes there may be multiple lines, either of similar or different degrees of difficulty. Sometimes there is only one survivable line, with dire consequences for any failure, delay or deviation. Identifying a line may involve advance inspection, known as scouting. Following a line in practice requires very rapid responses to short-term sensory and proprioceptive perceptions, with skilled actions aimed at matching the actual route to one's memory of the scouted line. If scouting is not feasible, the line must be run "blind," which may be substantially more difficult and dangerous. A person who successfully finds and follows a line is said to have nailed it.

One component in acquiring skills is to attempt a series of successively more difficult lines, either at the same or different sites, aiming to nail each one before progressing to harder lines. As individual practitioners become more skilled, they progress from locally known training sites, to nationally or internationally known sites and lines, and then to pioneering new lines. In this process they meet peers with whom they can compare capabilities. There are multiple steps in such comparisons. For some adventure activities, including white-water kayaking, there are internationally recognized degree-of-difficulty gradings.

In white-water kayaking, individual rapids are graded on a five-point scale, Class I to Class V. Class V is sometimes subdivided, or extended to a sixth level. Individual kayakers can be graded by their ability to paddle rapids of different grades. A Class V paddler is one who is confident to tackle Class V rapids. Class V, however, especially if extended to Class VI, covers a wide range: from difficult for a Class IV paddler, to extremely difficult and dangerous even for a world-class paddler. Even where gradings exist, therefore, practitioners still compare specific feats and achievements. Initially, they do this by listing sites they have visited: mountains, rivers or surf breaks. At the next stage, they list specific obstacles or runs: named descents, rapids, or waves. Finally, they consider specific named lines.

The Lava Falls Bubble Line

The Grand Canyon of the Colorado River in Arizona, United States is classed internationally as "big-water Class III." This means that the hydraulic features are powerful, because the river is of moderately high-volume flow; but that the individual rapids are only of moderate technical difficulty, III on a scale I-V. The Grand Canyon also has its own internal rapid-grading system, on a more finely divided 10-point scale, but that is not comparable with other rivers. Flow rates in the Grand Canyon are much higher than many steep creeks well known to kayakers, but far smaller than high-volume rivers such as the White Nile or the Congo, or monsoon flows in Himalayan rivers such as the Karnali and Sun Khosi in Nepal, or the Nu (Salween), Li (Mekong), and Yangtze rivers in China.

Demand for river trips on the Grand Canyon far exceeds supply. Supply is restricted physically by the availability of overnight camping sites, and legally by a lottery-based permit system operated and enforced by the US National Parks Service. Certain commercial raft companies have been granted grandfathered rights to run trips throughout the year, but private groups must apply repeatedly year after year, and hope for a chance to gain a permit and run a trip. Commercial raft companies are permitted to take kayakers, but generally prefer not to do so, because it reduces their client-to-guide ratio, and hence profitability. Except for commercial raft guides, therefore, any individual white-water kayaker will typically experience few opportunities, over the course of their life, to paddle the Grand Canyon.

The highest-graded rapid in the Grand Canyon is called Lava Falls, or just Lava. It is commonplace, in many white-water rivers, that individual rapids have names. For most kayakers, Lava is the crux, the most difficult rapid on this particular river. Depending on individual experience, the same kayakers may have paddled far more difficult rapids on other rivers, or they may not. Even expert river runners will generally scout Lava before running it, since it can change over time as the riverbed shifts, and water levels increase or decrease.

There are three main lines in Lava, established by the particular conformation of the rapid, and these lines also have names. Since this is a Class III rapid, expert Class V kayakers are not restricted to the named lines. For intermediate kayakers such as the author, however, the three standard lines are known as left, V-wave, and bubble-line. Each line has its own entry point into the rapid, and the kayaker must find that entry point accurately. They must then complete a specific series of boat maneuvers and associated paddle strokes, known as "moves," to nail the line, i.e., to follow the relevant line and exit the rapid safely. If they fail, they will get "worked" or worse. As a Class III rapid, the risk of fatality is low. To kayak Lava Falls is a skilled adventure activity, but not an extreme one in the sense of Brymer and Schweitzer (2017a,b), i.e., that any mistake is likely to prove fatal.

To explain these lines, some more detailed description and terminology is required. The main obstacle in Lava Falls is a large "ledge hole" in the center of the river, near the beginning of the rapid. A ledge hole is a hydraulic feature where water pours over a shallow underwater rock ledge. This gives the water downward vertical momentum, which punches the flow through the water surface downstream of the rock ledge, forming a seam. A kayak or swimmer falling into this seam will be sucked under water. The surface water downstream of the seam flows back upstream until it is sucked down again at the seam, forming an endlessly recirculating zone from which escape is difficult. That is, the underwater flow downstream of the ledge is shaped like a barrel with its axis across the river, its diameter reaching from

surface to riverbed, rotating so the water flow is downstream on the riverbed and upstream at the surface. Similar features, also known as pourovers, occur wherever a river runs over shallow underwater rocks. The intensity of the seam, and the plan-shape of the recirculating zone, depend on river dynamics and rock shape. Some are escapable at the ends of the seam, whereas some are endless traps. The Lava Falls ledge hole is long and straight, making it difficult to escape. Therefore, all lines through Lava aim first to avoid the ledge hole.

The left line, generally considered safest, takes a kayak or raft easily past the left hand end of ledge hole (left to a person looking downstream). Depending on river flow, the left line then delivers the boat into a confused maze of subsidiary waves, with no clear course. Mishaps, however, are unlikely to have severe consequences, as any swimmers will wash through the rapid well away from the main danger zones. The lines running right of the ledge hole are more stable in shape, but require greater precision and power. The water flow is compressed between the ledge hole and the right-hand river bank. This forms a series of standing breaking waves, oriented diagonally to river flow. These diagonal waves, known as laterals, meet in pairs to form V-waves. The V-waves form a wave train. The first V-wave is particularly powerful. A boat taking the V-wave line aims to hit that largest V wave with speed and momentum, so as to punch through or over it.

A kayaker will aim to hit the right lateral wave slightly to the right of the point of the V, with their boat angled slightly to the left. This is so that the wave will push the boat diagonally toward the left, away from the river-bank, as it exits the first V-wave. This is important, since below the train of V-waves is the Black Rock, which protrudes from the shoreline into the downstream tail of the rapid. The Black Rock is potentially dangerous for three reasons. First, it is sharp: it is also called the Cheese Grater. Second, at some river levels the water flows through a narrow slot between the Black Rock and the main river bank, and a kayaker or swimmer who was washed into that slot could become stuck under water, and drown. Third, immediately downstream of the Black Rock is a powerful whirlpool, which can suck a kayaker far enough under water (as the author once discovered by experiment) that no light reaches one from the surface. The right V-wave line thus requires strong commitment and no hesitation, and the readiness to roll one's kayak upright quickly if the V-wave hurls it upside down. It does not, however, require any very precise moves. This line is the one that most kayakers aim for.

The third line, the bubble line, is a more precise line than either of the other two. It relies on a very small section of more slowly flowing water, a sweet spot, at the extreme right hand end of the ledge hole. If a kayaker can reach that small zone upright and pointing downstream, there is a brief opportunity to avoid all the major obstacles: the ledge hole, the V-wave, the Black Rock, and some additional large waves in the center of the river downstream of the ledge hole. To follow this line, the kayaker must swing left in the sweet spot at the corner of the ledge hole, and paddle hard into the center of the river, bracing for impacts as the boat washes diagonally into these lower waves. That move requires timing, power and precision. Importantly, it also requires that the kayaker reach the sweet spot accurately, and that in turn requires nerve. Some rivers and rapids, such as the North Fork of the Payette River, require an endless series of powerful turns on marginally slower-moving water. For the Lava Falls bubble line, there is only one, but it has little margin for error.

For a kayaker entering the rapid, none of the features outlined above are visible. They are all hidden below the horizon line, where the rapid falls off from the smooth flowing water upstream. To reach the sweet spot, the kayaker must follow small cues visible in that upstream water flow. In this case, the cue is that in the smooth tongue of water entering the main flow right of the ledge hole, small boils form intermittently as water is pushed to the surface. These boils look like a line of widely spaced bubbles, each growing to about 50 cm in width and then vanishing. They are not entirely consistent in position, but generally they mark the place a kayak must be if it is to pass through the sweet spot. Hence, of course, the name bubble line. The term boil line already has a more general meaning in describing white-water hydraulics, so bubble line is the preferred name for this particular run.

The bubble line requires particular boldness, because to a kayaker entering the rapid, it appears that it leads straight into the ledge hole. If the water flowed directly downstream, it would. But it does not. The tongue of water marked by the bubble line diverts sideways around the edge of the ledge hole. The bubble line marks the extreme left hand position at which a kayaker will be carried past the corner of the ledge hole. Any further left, and the kayak will be dropped into the hole, with carnage in consequence. The water flow accelerates as it runs toward and around the corner of the ledge hole, and the kayaker can look down into the pit of the ledge hole as she or he passes it. Even more nerve-wracking, at some water flows there are several small smooth waves and one small "rooster tail" wave which one must paddle through before one can see one's position relative to the corner of the ledge hole.

If a kayaker holds course exactly, and does not lose nerve, the water flow pushes the boat sideways past the ledge hole, and immediately below the rooster tail is the sweet spot where the powerful turn must be made. That sweet spot is less than a meter across, in the midst of a rapid over 100 m wide and hundreds of meters long. It is sometimes covered in spray, and it is right next to the roaring sound of the ledge hole. It is invisible until one is in it, yet one must be ready to react the instant one hits it. If a kayaker loses nerve even slightly, paddling even 50–100 cm right of the bubble line so as to be sure of missing the ledge hole, they will miss the sweet spot, and instead be swept into the V-wave. Worse still, instead of hitting the V-wave head-on, with speed, and momentum away from the Black Rock, they will hit it sideways, more slowly, with momentum toward the Rock. The Lava Falls bubble line is thus one of the premier tests of nerve in the entire Grand Canyon. A kayaker who nails the bubble line seems to slide cleanly through the rapid in an effortless dance; but only if they nail it. If they fail, the consequences may be messy. The Lava Falls bubble line thus provides a good tool to examine the psychology of aging in white-water kayakers.

Autoethnographic Data

I have made five descents of the Grand Canyon, over a period of decades. The first was in a raft, as a volunteer in a research study of native fish species endangered by the Glen Canyon Dam. The

other four were in a kayak. My first kayak descent was as a client in a guided commercial trip. It took place during the late 1980's, when I was in my early thirties. The trip was principally a raft trip, but there were three or four kayakers, and the company also sent a kayak guide, as required by USNPS regulations. By the time we reached Lava Falls, which is in the lower section of the Grand Canyon, I had already "swum" twice. That is, I had accidentally tipped my kayak upside down, been unable to roll it back upright, and been forced to bail out and swim to the surface for air. These swims had occurred whilst I was trying hard to surf particular waves in my kayak, and had become exhausted through multiple attempts. They were not in dangerous places, but they had caused concern for the kayak guide. I had no swims in the other three trips, but others did, some requiring rescues.

Commercial raft trips on the Grand Canyon build up client expectations and trepidation during the night's camp above Lava Falls, through a series of games and anecdotes. These are designed to frighten the clients, so as to increase the intensity of the experience, and incidentally their respect and gratitude to their guides for navigating them safely though the rapid. It is part of the standard emotional choreography for this product. None of the kayaking clients had run the Grand Canyon before, and we asked the kayak guide for a detailed description of Lava Falls. Using wet sand at the river's edge, he constructed a static three-dimensional representation of the ledge hole and V-wave, and told us to aim for the center of the V-wave, point directly downstream, and paddle hard. These instructions were good, because they were simple. It is hard to recall complicated instructions when fearful.

The next morning, we reached Lava Falls and landed on the right hand bank to walk downstream and scout the rapid. The ledge hole looked very unpleasant. But I knew that people had swum through it and survived. The raft guides discussed amongst themselves whether to run right or left. Most commercial trips, where guides have nothing to prove, will run left, unless either the water level makes the right line safer, or their clients specifically ask to run the V-wave. The kayakers looked carefully at the rapid, mentally matching it to the model made by the kayak guide. The instructions were simple. Stay in the middle of the main right-side tongue, and hit the V-wave straight and hard. I could do that. But as I watched the tongue, I saw the boils forming the bubble line. I watched for a while, and saw that each one slid around the extreme end of the ledge hole. Why could I not do that too? At the time, I did not know that this was a recognized line, the bubble line. Our guide, quite rightly, was not offering us a choice. His job was just to get us safely through the rapid, despite our inexperience.

I was the weakest of the kayakers, so I was left to run last. That way, the other kayakers would be waiting at the end of the rapid, in case I might need rescuing. We all launched from the muddy bank at the same time, and waited in our kayaks, hearts beating fast. The guide told us to follow each other a few minutes apart. Should I crash the V-wave, or try to follow the boils? I had a few minutes to decide. They went fast. Either way, I should start by paddling back upstream a little, to get safely on to the tongue of water. I did so, still undecided. Then a boil broke to the surface a little to my left. I can't remember what I thought, only what I did. I paddled to the boil, and waited. At first the flow seemed slow. Then it picked up speed. As the ledge hole came into view, it seemed that I would surely fall into it. I could see right into its maw. But I slid past, exactly at the point to take a giant paddle stroke hard left, and successfully through the rest of the rapid. As my heart rate slowed slightly, the guide paddled over, asking how I had ended up so much further left than the others. I explained. He said nothing, but shook his head slowly.

My second Grand Canyon trip was two decades later in 2008, when I was about 54. It was just after the USNPS changed the permit system for private trips, from a queue to a lottery. The queue had reached >20 years. In the changeover, they had to be sure not to disadvantage people already in the queue, since arguably those people had legal rights. They adopted a system where they gave people extra places in the lottery, depending how many years they had been in the queue. In addition, they offered that if individual trip leaders cared to combine to a single group, they could combine their lottery points. Using this approach, I found myself in a mixed private group, led by a very experienced Grand Canyon river runner. The group included young wounded US war veterans, learning to kayak under a rehabilitation program known as Wounded Warriors. They were injured and inexperienced, but fearless. They had their own kayak guides, so I was a supernumerary, left to paddle at my own pace, and occasionally lend a hand at a rescue. At Lava Falls I ran the bubble line, and once again, it went smoothly. Nobody else chose that line, and I did not suggest it.

My third Grand Canyon trip was in 2012 at age 58, on my own permit. That is, I was the one who won a place in the lottery, became the trip leader in the eyes of USNPS, and had the right to invite other participants, but the responsibility of organizing the logistics. Fortunately, I was able to invite several very experienced rafters and kayakers, who took over as leaders as soon as we were on the river. It all went well. I borrowed a kayak with plenty of leg room, and in the flat water sections, I drifted with my legs on the front deck. This was to ease the pressure on my aging spine, injured in accidents long previously. Water flow was relatively low, and Lava Falls looked less intimidating. I went first, whilst everyone else was still standing on the river bank, taking photos and videos. I ran the bubble line, but my nerve was weaker than previous trips. Instead of sticking exactly to the bubble line, I was about 50 cm to the right of the sweet spot. I passed the ledge hole safely, but got sucked backward and sideways into a plunging wave downstream, and pushed toward the Black Rock. I was able to escape with a brace, a paddle stroke that prevents a roll, but in a video of my run, one can hear comments that I was lucky.

My fourth trip was in 2016, a last-minute invitation from a generous friend of a friend. He needed a single person to replace a drop-out in a long-organized trip, to avoid the need to recalculate the entire budget. I was 62, by far the weakest and oldest kayaker. My skills were reasonably intact, but my stamina was gone. Past injuries, unrelated to adventure activities, had taken their toll, and a couple of days before we reached Lava Falls, I found myself unable to sit in the kayak all day. So, reminding myself that I was old enough to take some liberties, I hauled my kayak onto a raft and rested, whilst the younger and stronger participants did the hard work rowing. I got back into my kayak just to run the larger rapids, such as Lava Falls. Water levels were high, and

the water was a rich muddy red-brown, colored by inflow from side streams. The V-wave was a chaotic liquid sculpture, tossing and churning, and the other kayakers were raring to go. They did not care about the bubble line. The boils were harder to see in the muddy water, and they thought I was making it up. They all decided to hit the V-wave. I was tempted to do likewise. But would that be a cop-out?

Was I afraid to run the bubble line? For sure, nobody else cared. But I did. It was a measure of my own self-esteem. The bubble line needs least strength, but most nerve. I was influenced by a chance encounter a few days earlier. We had met a group of scientists working on threatened native fish species. They had big motor-powered rafts, but also a speedboat. In my very first raft trip as a research volunteer, we had used an outboard-powered inflatable to get up and down the river further upstream, but we deflated it and packed it away before we ran Lava Falls. That would not be possible with a metal speedboat. I asked the speedboat pilot, a veteran fish scientist with many runs to his credit, how the logistics worked. He said that he simply ran the boat through every rapid, Lava included. I asked him whether he ran the bubble line, and he looked at me keenly for a few seconds, eventually answering only, "Yes." That gave me pause for thought. Certainly, it was the only option smooth enough for a speedboat. But it would need nerve. A speedboat is a lot faster and more powerful than a kayak, but it can't roll, and it would suffer much more severe damage if it ended up in the ledge hole. If he could run a speedboat through the bubble line, I thought, surely I could paddle a kayak. So I did. And yes, it went smoothly. But I'm not sure if I would do it again.

What can we deduce, by comparing these recollections of runs by the same person down the same line in the same rapid, over a period of some three decades? How and why did skill, fear, thrill, and self-esteem change over that period (**Figure 1**)? Fear in anticipation, pre-event fear in the terminology of Buckley (2016), did not increase. Despite the long intervals between successive runs, one does gain a certain degree of familiarity, and hence confidence. Fear during the run itself, in-the-moment fear, was highest as I looked down into the ledge hole on the first run. Thrill was high in each case, and my recollections are not precise enough to distinguish confidently which was highest, though I think probably the first. Skill was probably highest in the second, when I had gained more experience than for the first, but had not suffered such a noticeable physical decline as during the third and fourth.

And what about self-esteem? I am glad, and relieved, that I ran the line successfully each time. I think that my self-esteem would have suffered if I had decided not to attempt it. Is this foolish? Probably. Indeed, perhaps the decision to pick the bubble line was at least partly due to pride. On the first trip, perhaps the bubble line was a way to compensate for my swims, to show that I was not incompetent. On the second, I seem to recall a feeling of ownership, that the bubble line was "my" run through Lava. On the third and fourth, when I was undeniably already old, I was testing myself against my own self-perceptions. But my self-esteem did not suffer from electing to ride on the raft during the latter part of the fourth trip. I had recognized by then that I was growing old, and had no choice but to lower my aspirations. Besides, it is not a difficult line, in global kayaking terms. It was a bucket-list item before my first trip, but after that, it is not a measure of lifetime achievement. It is not even the most difficult line in the Grand Canyon. There are other rapids with larger waves, exploding waves, rocks in the center of the river, and powerful seams. Even so, however, it provided me with a benchmark, something that showed me that despite advancing age and the many things I could no longer do, at least there were some that are still within my capabilities.

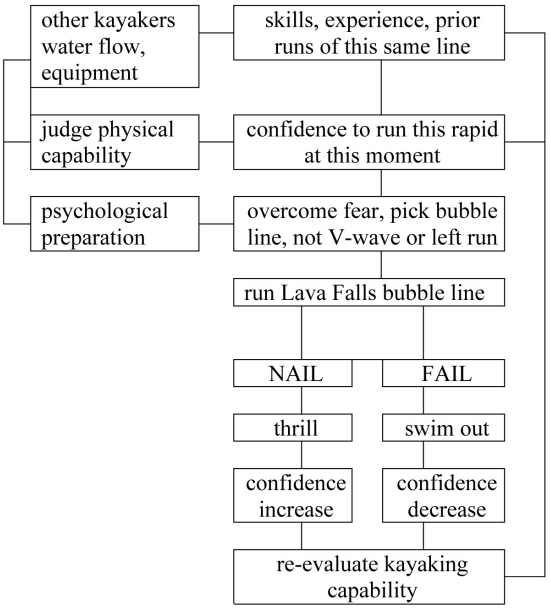

FIGURE 1 | Nail or fail the Lava Falls bubble line.

Additional Incidents

There are other autoethnographic incidents that can be compared, to illuminate findings from the Lava Falls bubble line, and illustrate the breadth of data available. In a number of raft and kayak first descents in China many decades ago, when I was in my forties, I was the lead or probe kayaker. This is the person responsible for paddling ahead into an unknown river, judging the obstacles, and signaling back to the other boats. Some of these rivers included difficult rapids, which I ran successfully (Van Beek, 1998). These trips took place over an extended period of years, and I became older. Eventually, in my mid-fifties, I realized that I need no longer try to run every rapid or take responsibility for decisions, because we had a younger and much more competent kayaker in the group. His skills and judgment were much more reliable than my own, so my best strategy was to follow his instructions. It was both a disappointment and a relief, but it was a memorable moment, a shift in attitude. I can recall the exact place and instant when I reached this realization.

Years later again, in 2017, I took part in a multi-day raft trip on an easy, commercially run section of river in the eastern Tibetan Plateau. I was kayaking, and there was one other kayaker. She was much more competent than I, and paddled with me in a casual

and friendly way. It took me some time to realize that the trip leader, much younger but much more competent than myself, had detailed her to keep an eye on me. He had not told me so explicitly, in case I might be disgruntled. It was kindly done, and allowed me to keep my self-esteem largely intact, though I could see that my skills had declined greatly from past years.

Tests of past skills do not always work out so well. In decades past, I was a heavily addicted sailboarder, and I waited for those special days when a big southerly storm would sweep in to a particular river-mouth point break. These conditions, which might happen several days in a row or not at all for years on end, brought strong south-easterly winds and mast-high or larger swells. The river mouth provided just enough shelter to get out through the breaking waves, and once well out to sea, one could pick up the green swells far out in the bay, and ride them back toward shore. As each swell neared the point, it steepened and broke, and one could turn the sailboard downwind, and ride the breaking wave like a surfer, eventually pulling over the back of the wave, just before it closed out in a flurry of unrideable foam. It took skill, strength and balance, and there was little room for error, but it was extremely addictive.

There is another site not far away, where a larger river runs out between two big rock walls, known as training walls because they train the outgoing tidal flow into a fast-flowing jet. On the biggest days of all, I would carry my sailboard into the outgoing flow, murky and sharky, and wait to be washed out through the heads of the training walls, where a big swell would break well out to sea. Once beyond the reach of the walls, there would be enough wind to raise the sail and ride the breaking waves, taking care not to be washed far out to sea, or into a rocky headland. The last time I did this, however, is many years ago.

Over the past decade, since kiteboards became widely available, my sailboard has got little use. When a moderately sizeable southerly swell rolled in during October 2017, however, I recalled past days, rigged it up, and sailed out from the (smaller) river mouth. Unlike the sailboard fleets of yore, only two other sailboarders were out there. But I found myself lacking in strength, fitness, and skill. Instead of sailing and surfing back and forth all day, I found myself worn out after only a few runs, none of them spectacular. I made an elementary mistake, and was caught in a zone with breaking waves and no wind, and washed ashore. Because of incoming tides and a sand dredge operating in the river estuary, it took me over an hour to walk back with all my gear, along the road. My aspirations were still based on memories, but my capabilities had definitely dropped. It was a rude reminder of aging.

All the data outlined above are autoethnographic. It took 1750 words to describe the Lava Falls bubble line, and a further 2000 words to describe just four runs through that line by a single kayaker, even at a basic descriptive level. Each run took a couple of minutes at most. To construct a general model, I have relied on hundreds or perhaps thousands of analogous memories, across many days of kayaking, sea-kayaking, skiing, snowboarding, surfing, sailboarding, kiteboarding and other adventure activities. Many of these memories include other participants, who watched me as I watched them, and later discussed their past experiences, skills and confidence, capabilities and feelings, in various degrees of detail. To move to a more generalized model, I rely on this much broader bank of memories, as below.

Ethnography of Aging in Skilled Adventure Athletes

In this section, I present my perceptions of general patterns associated with aging and self-esteem in skilled adventure athletes. As noted earlier, these perceptions are perhaps best treated as one person's hypotheses, available for future testing, rather than a definitive statement. I am confident that they apply to myself, and also that they apply in general terms to many others with whom I have spent time in adventure activities. I cannot be confident, however, that they apply to individuals whom I do not know in person, or those who engage in different adventure activities, or to adventure athletes in general. With those caveats, here are my findings. Components are summarized in **Figure 2**, a generalization from **Figure 1**.

For skilled outdoor adventure athletes, the physical effects and psychological recognition of aging includes numerous subsidiary components. An individual's reserve of strength declines with age; their reaction time slows; and their flexibility decreases. Their ability to foresee potential mishaps and plan reactions, however, may improve.

When adventure athletes are young, their skills and aspirations increase concomitantly. Initially, both are low. Typically, there may then be a period of rapid learning, when skills may exceed aspirations. As their knowledge of opportunities and peer achievements increases, their aspirations also increase. As they get older, their aspirations remain high, but their skills start to decline, and their susceptibility to injury increases. Once

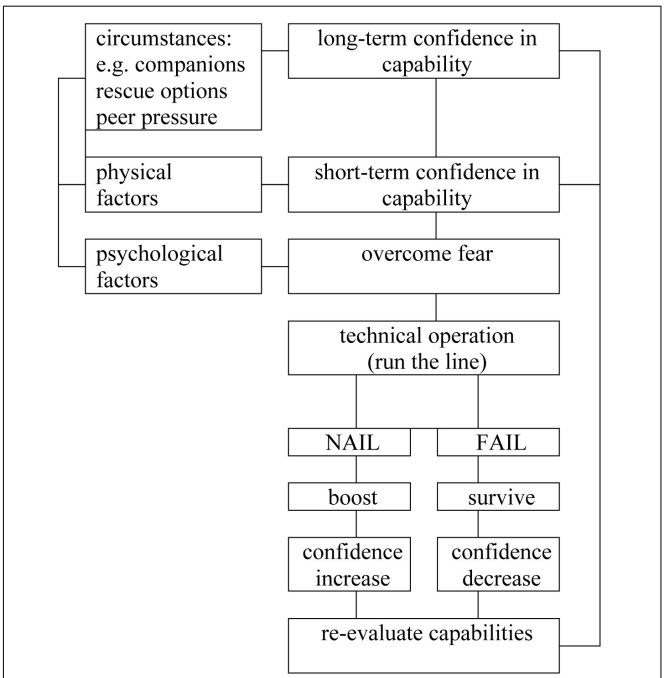

FIGURE 2 | A generalized nail-or-fail model for aging adventure athletes.

practitioners start to experience more mishaps and injuries, there is then a lag before they realize that they are past their prime and need to reduce their remaining aspirations. This lag, and the associated psychological adjustment, is strongly associated with self-esteem.

As the effects of aging first begin to make themselves felt, individual adventure athletes generally maintain high aspirations, in order to maintain self-esteem. During this period, their peers may assume that their skills remain adequate. The decline in skills may be hidden for a while, as practitioners can compensate to some degree, by buying better equipment and safety gear. This in itself is not an obvious indicator of decline, since the overall culture of safety is increasing for younger generations.

The decline in skills may also be hidden as individual adventure athletes begin to practice their preferred activities less frequently, because of other priorities and commitments. Even if they can see clearly that their capabilities are reduced, they may ascribe this to reduced fitness and less practice, which they may see as reversible. They may take longer to learn new skills, but attribute this to lack of practice. Overall, they expect to be able to perform as previously, but their actual physical capability has decreased. This increases the probability of misadventure and mishap. It may be these mishaps that finally force the individual to overcome this period of denial.

After this period of denial, the individuals concerned, and their peers, recognize that their skills are declining. Initially, this leads to a fall in their self-esteem. Eventually, however, they recognize that the same decline also applies for their peers, and is an unavoidable aspect of aging. With that realization, they accept it and adjust their expectations accordingly. They still wish, however, that they still had their former skills. They still struggle to maintain those skills, and they still continually measure their remaining capabilities, and attempt to minimize the decline.

During the period when individual adventure athletes recognize that their skills have begun to decline, they may also experience increasing uncertainty in their own evaluation of their own capabilities. They recognize that they are becoming slower and weaker, more easily tired, and more susceptible to heat and cold. They have more accumulated injuries and illnesses, and lower reserves of stamina. They learn to leave a safety margin when deciding how much to do in a day or a session, and they learn that they must plan exit and rescue strategies for multi-day trips. As all these factors reduce their overall capability, aging adventure athletes should logically reduce their aspirations accordingly.

They feel concern, however, that lowered aspirations might represent loss of courage, rather than an accurate reflection of reduced capability. For adventure athletes, courage is an important component of self-esteem. If it becomes difficult to distinguish whether reduced aspirations are realistic or fearful, that introduces additional uncertainty into assessment of self-esteem. This introduces a risk that individuals will attempt unrealistic feats, to prove to themselves and their peers that have not lost courage. Peer psychology has an important role to play in boosting or preventing this.

CONCLUSION

Feedback Mechanisms

How do adventure activities influence self-esteem? Self-esteem depends on an internal comparison between achievements and aspirations (James, 1890/1983). For adventure athletes, both achievements and aspirations receive feedback via nails or fails (**Figure 3**).

Time Dimension

I suggest that both achievements and aspirations possess a time dimension, and that this dimension has two components. The first component of the time dimension is simple: both capabilities and aspirations change over time, in line with the "leisure lifepsychle" model put forward by Buckley (2017).

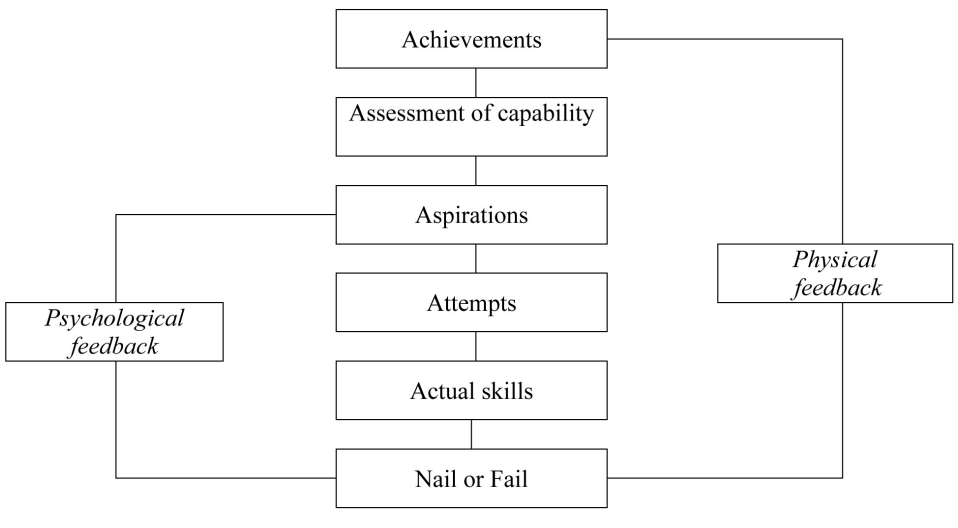

FIGURE 3 | Achievements, aspirations, and assessments.

The second component of the time dimension, apparently not suggested previously, is more subtle. An individual may compare his or her own achievements and aspirations either in the past, the present, or the future. The direction of view has a major effect on the outcome of the comparison; and that effect depends on age. An older individual with a lifetime of adventure achievement, for example, may recognize that they are on the downward arc of their leisure lifepsychle, but may be content with what they have done. They have no further aspirations, so their self-esteem is established by their past mastery. This self-esteem cannot be taken away, except through loss of memory.

An older individual who is still practicing adventure activities, and trying to prevent a decline in capability, may set their current aspirations with reference to past achievements. Their self-esteem depends on what they can achieve currently. As they grow older, this is likely to lead to losses in self-esteem, until the aspirations are adjusted to take account of aging. A younger individual whose skills and capabilities are still increasing is more likely to look forward, with high aspirations for future achievements. Their self-esteem is based on their own assessment of what they may achieve in future, not what they have already achieved in the past, or even what they can currently achieve in the present.

The autoethnographic accounts provided here identify two specific aging thresholds in self-assessment of achievements and aspirations, and these may apply well beyond the particular field of outdoor adventure. The first threshold occurs when an individual recognizes that there are other individuals, younger than them, who are more competent and have better judgment. During the course of the leisure lifepsychle (Buckley, 2017), younger individuals initially defer to the expertise of their elders, but eventually supplant them. The threshold identified here reflects the reverse process, when older individuals begin to defer to the judgment of their younger companions. The second threshold occurs when an aging individual recognizes that not only are they no longer a leader, but they are in fact a burden, someone who needs assistance. For self-esteem, this is a severe realization, which requires substantial mental readjustment. Perhaps these thresholds may apply to professional life histories in general.

Basis for Comparison

Self-esteem is based on different comparisons for different individuals, depending on what they see as important (Chen et al., 2016; Du et al., 2017; Stephenson et al., 2017; Strandell, 2017). There are three main components of this: who, when and what. The first and second components depend on whether they compare only against themselves, the "personal best" school of thought; or whether they compare themselves against others, the "peer competition" approach. For example, does a kayaker compare their current rapids and runs against their own best runs in the past, or against the runs they hope to make in the future, or against the abilities of their friends currently, or against the most difficult rapids ever run and lines ever nailed by anyone anywhere? The third component is how broad a portfolio of activities and achievements they include in their comparison. Is it focussed on a single field or activity, or does it include several or many? For example, do kayakers compare themselves only on the basis of kayaking; or do they also consider other adventure activities, or other aspects of their personal and professional lives? Can a lesser achievement in one field, be offset by a broader range of fields? There is no single answer: the basis for self-esteem depends on the individual.

Adventure, Aging, and Mental Health

Self-esteem is important to health; self-esteem of adventure athletes depends on adventure capabilities; and these capabilities decline with aging. Does this condemn aging adventure athletes to declining self-esteem, and consequently to declining mental health? In particular, could this mechanism cause faster declines in mental health for aging adventure athletes than for non-participants?

These are important questions, if we propose to adopt outdoor adventure activities as one component of mental healthcare (Clough et al., 2016; Buckley and Brough, 2017). As yet, there seems to have been no systematic tests. The evidence and arguments presented above, however, suggest that adventure has a positive overall effect on self-esteem, for two key reasons. The first reason is that nailing a line, or its equivalent in various outdoor adventure activities, provides a powerful boost to self-esteem, in a way that is not available to non-participants. As long as aging adventure athletes can continue to nail their lines, this insulates them against losses in self-esteem. The second reason is the ability to look backward as well as forward, in comparing achievements against aspirations. An aging adventure athlete who has a lifetime of nails and fails to look back upon may gain self-esteem from the past, even as they know that their future must be less athletic.

Looking Forward

Is this field of research important? Yes. Chronic disease syndrome, various combinations of depression, dementia, diabetes and obesity, imposes costs on the economies of developed nations equal to around 10% of their current GDP (Buckley and Brough, 2017). Outdoor nature, eco and adventure therapies can reduce those costs. Outdoor exercise reduces risks of both physical and psychological ill health, and adventure activities are a key component. This is now a heavily studied field of public health and psychology, but the focus has been on physical exercise (Lee et al., 2017) and passive exposure to nature (Frumkin et al., 2017), not on outdoor adventure activities as such. That provides research opportunities for those with interests in adventure sports, tourism and recreation. Some of these research opportunities are neurobiological and physiological (Grubb et al., 2016; Sun et al., 2016; Lee et al., 2017; O'Donovan et al., 2017). Others, however, are psychological, with particular reference to self-esteem and mental health (Orth et al., 2015; Tilley et al., 2017).

What research do we need? The framework outlined above suggests a number of directions. In addition, much of the specific research cited here deserves duplication, for other adventure activities and participants. Boyes (2013), Hickman et al. (2016, 2017), and Wheaton (2017) interviewed hikers, climbers, sea-kayakers and surfers aged in their sixties and older. We need more such studies. There are corresponding groups in many

adventure activities. Indeed, there are legendary characters in some activities, some still taking part in their nineties. These individuals deserve our respect, but we can also pick their brains and mine their memories. Which of their capabilities did they maintain or lose, and when, and how did it affect their self-esteem? In particular, do the two thresholds of realization identified above, where aging individuals recognize their loss of capability, apply broadly across all adventure athletes and activities? If so, might they also apply to aging more generally?

My focus here has been solely on self-esteem. There are many other parameters we might consider. Examples include: self-identity and associated concepts; mind-body interactions and performance; risk acceptance or aversion; physical skills and mental judgments; and emotional reactions to challenges and achievements. How does each of these change with aging, in different individuals? Perhaps we could analyze this through a novel research approach, which we might describe as a massively parallel autoethnography. That is, a large number of coauthors, each with professional skills in outdoor adventure, could apply autoethnographic approaches to their own experiences in parallel, and compare their results. I would gladly take part in such an approach, if others might be interested.

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RB conceived, designed and conducted research, and wrote the article.

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Affordance Realization in Climbing: Learning and Transfer

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The aim of this study was to investigate how the affordances of an indoor climbing wall changed for intermediate climbers following a period of practice during which hold orientation was manipulated within a learning and transfer protocol. The learning protocol consisted of four sessions, in which eight climbers randomly ascended three different routes of fixed absolute difficulty (5c on the French scale), as fluently as possible. All three routes were 10.3 m in height and composed of 20 hand-holds at the same locations on an artificial climbing wall; only hold orientations were altered: (i) a horizontal-edge route (H) was designed to afford horizontal hold grasping, (ii) a vertical-edge route (V) afforded vertical hold grasping, and (iii), a double-edge route (D) was designed to afford both horizontal and vertical hold grasping. Five inertial measurement units (IMU) (3D accelerometer, 3D gyroscope, 3D magnetometer) were attached to the hip, feet and forearms to analyze the vertical acceleration and direction (3D unitary vector) of each limb and hip in ambient space during the entire ascent. Segmentation and classification processes supported detection of movement and stationary phases for each IMU. Depending on whether limbs and/or hip were moving, a decision tree distinguished four states of behavior: stationary (absence of limb and hip motion), hold exploration (absence of hip motion but at least one limb in motion), hip movement (hip in motion but absence of limb motion) and global motion (hip in motion and at least one limb in motion). Results showed that with practice, the learners decreased the relative duration of hold exploration, suggesting that they improved affordance perception of hold grasp-ability. The number of performatory movements also decreased as performance increased during learning sessions, confirming that participants' climbing efficacy improved as a function of practice. Last, the results were more marked for the H route, while the D route led to longer relative stationary duration and a shorter relative duration of performatory states. Together, these findings emphasized the benefit of manipulating task constraints to promote safe exploration during learning, which is particularly relevant in extreme sports involving climbing tasks.

Keywords: motor learning, affordance, exploration, perception, climbing

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INTRODUCTION

Research indicates that the realization of a multitude of skillful human behaviors, including throwing (Zhu and Bingham, 2010; Wilson et al., 2016), catching (Peper et al., 1994; Montagne et al., 1999; Zaal and Michaels, 2003), and climbing (Seifert et al., 2014b) are predicated on the accurate perception of affordances (i.e., opportunities for action; Gibson, 1979). The accurate perception of an affordance entails an individual's ability to perceive what the environment offers her or him relative to her or his own abilities (Fajen, 2005; Chemero, 2009; Withagen et al., 2012). For instance, in a seminal study, Warren (1984) reported that despite differences in body size, young adults accurately perceived stairs as no longer climbable in a bipedal fashion, when the step's height exceeded 88% of their lower limb's length (for further considerations, see Konczak et al., 1992; Cesari et al., 2003).

How are affordances perceived? The perception of affordances is believed to rest on the pick-up of information that specify patterns in ambient stimulation, or so-called invariants[1] (e.g., Gibson, 1979). These patterns are not to be thought of as pre-given structures that would be imposed on passive sensory receptors (as would a picture or movie on a screen), rather they are actively sought after by perceiving individuals (hence the use of *perceptual systems* in place of *senses*; Gibson, 1966; Stoffregen et al., 2017). It follows that, through action, individuals learn to create information to support performatory movements using *exploratory* actions. While the distinction may not be exclusive, it is worth noting that in humans exploring appears to be the nature of actions first used for during the first moments of life (Gibson, 1988).

Exploratory actions can be of two different kinds. First, they may be intrinsic to the act of perceiving. Indeed, since behaviorally relevant characteristics of the human-environment fit are specified in the patterns of stimulation and since these patterns are contingent on the perceiver's motion, then she/he literally (co-)constructs information through her/his actions (Mantel et al., 2015). Second, exploratory actions may be used to seek (new) information (e.g., invariants allowing better performance or efficiency); that is, they may support perceptual learning (i.e., learning to perceive affordances). Such exploratory actions are pervasive in children, playing a core role in development and are no less important in adults for they constitute the basis of their perceptual ability to adapt to new situations and develop new skills (Gibson, 1988). The invariants specifying affordances are contingent on nested information suggesting that postural stability, reaching and grasping a hold are all actions nested within the process of climbing to end of a route—each with potentially specific exploratory actions.

What do information-gathering actions look like? Depriving or restricting participants in their exploration have been showed to hinder affordance perception (e.g., Mark et al., 1990; Mantel et al., 2015) and recalibration (when action capabilities have changed; e.g., Mark et al., 1990; Withagen and Michaels, 2002; Wagman and Van Norman, 2011). For example, not allowing participants to move or requiring the adoption of an awkward stance (with feet together and toes apart) degrades their capacity to judge the maximum height on which they could sit (Mark et al., 1990). Furthermore, when wooden blocks are attached to the foot soles (which changes sitting capability), standing participants leaning against a wall do not exhibit recalibration in their judgments. In contrast, non-leaning participants, and participants allowed to walk between trials, recalibrate judgments to more accurately perceive optimal sitting height. Exploratory actions also seem to be tailored to the affordance to be picked up, and, yet, they may (e.g., Michaels et al., 2007) or may not (e.g., Mark et al., 1990) resemble the action afforded. If perceptual learning is conceived as a process of differentiation (i.e., attending to different, more useful, invariants; e.g., Gibson and Gisbon, 1955) rather than a process of enrichment (i.e., attending to the same cues, but interpreting them in a better way), one may expect a change in exploratory behavior as learning develops. The precision of affordance judgments has been reported to be contingent on the type of exploratory activity used by participants (e.g., Mantel et al., 2015), and participants that improved in their judgments have been observed to exhibit properties in their exploratory activity that non-improving participants do not (e.g., Stoffregen et al., 2005).

Specific to the development of expertise, it has been proposed that skilled performers in domains such as sports, perceive and realize affordances across a larger range and with greater accuracy than novices (Fajen et al., 2009). When considering the skill of climbing, Gibson (1979) suggested that "*slopes between vertical and horizontal afford walking, if easy, but only climbing, if steep and in the latter case the surface cannot be flat; there must be holds for the hands and feet*" (p. 132). Therefore, although a steep 10 m high wall does not afford walking (bipedal locomotion), it may afford climbing (quadrupedal locomotion) for the individual with the required abilities. *Climbability* depends on the relation between the characteristics of an approximately vertical surface and its layout (e.g., holds for the hands and feet) and that of an individual, which constrain her/his reaching, grasping and using holds as the basis for quadrupedal locomotion. Importantly, rock climbing does not only correspond to continuous upward body displacements, but also includes stationary positions dedicated to exploring and grasping surface holds (Pijpers et al., 2006; Sibella et al., 2007), postural regulation (Bourdin et al., 1998, 1999) and route finding (Cordier et al., 1993, 1994). Route finding skill reveals the ability of climbers to adapt to the ever-changing structural and functional features of the climbing wall (Cordier et al., 1993, 1994), in order to explore actions, including opportunities to grasp a hold in a certain way (e.g., crimp, pinch, slope) and to use the hold within a particular coordination mode (e.g., arm crossing or dual grasping on the same hold; Boschker and Bakker, 2002). Therefore, rock climbing is a complex form of locomotion as it involves interspersed periods of perceptual-motor exploration for route finding (Button et al., 2016; Seifert et al., 2017) with combinations of upper and lower limb movements to ascend the surface safely and fluently (Nougier et al., 1993; Boschker et al., 2002; Sibella et al., 2007).

[1]Invariants are subsets of the spatio-temporal structure of light converging at the eyes, of sound at the ears, etc. which specify properties of the individual-environment system such as affordances.

The time spent in exploration, postural regulation and ascent, or more broadly, the time spent stationary or in motion, can be analyzed by quantifying the durations when the hip (as an indicator of the center of mass) is or is not in motion (Billat et al., 1995; Sanchez et al., 2012; Seifert et al., 2013, 2014b). Billat et al. (1995) noted that experienced climbers spent 63% of a route duration stationary and 37% ascending. Pijpers et al. (2006) distinguished between exploratory and performatory movements through the analysis of holds that were and were not used during the ascent. Exploratory movements occurred when grasping actions oriented toward a particular hold did not subsequently lead to the use of that hold during the ascending climb, whereas performatory movements corresponded to hand grasping actions performed with simultaneous ascending hip motion. Using the ratio between touched-grasped holds and used holds, Sibella et al. (2007) reported that skilled climbers tended to touch fewer than three surface holds before *using* the functional hold. Moreover, Nieuwenhuys et al. (2008) showed that exploration for route finding or hold reaching and grasping does not only occur through hand movement, but also through visual exploration when the climber is stationary or regulates her/his posture.

It is plausible that a high number of exploratory movements may reflect low route finding skills in the sense that the climber may not immediately detect hold depths (Nougier et al., 1993) or hold orientations (Seifert et al., 2015) in relation to her/his own characteristics and ability to perform ascending actions. Such suggestion was recently examined through the manipulation of the hold orientations on a climbing route, which invited different grasping actions; namely, horizontal, vertical, and double-edge (i.e., both horizontal and vertical orientation were available) holds (Seifert et al., 2015). The route designed with double-edged holds led the climbers to exploit both a pre-existing behavioral repertoire consisting of a horizontal hold grasping pattern and trunk facing the wall and to explore new behaviors, specifically, vertical hold grasping and trunk facing side-on to the wall (Seifert et al., 2015). These findings indicated that the climbers functionally explored so that they became attuned to the information that specified the different ascending behaviors. In the study of Seifert et al. (2015), functional exploration entailed two aspects: (i) the climber did not use only one part of the body such as the right hand to reach the hold, but she/he used the whole body by adapting the rolling motion of the body to provide support for the pattern necessary to grasp the hold (horizontally or vertically); and (ii) while using the whole body coordination just described, the climber was able to achieve the same performance outcome, for example in terms of route completion and climbing fluency.

Although exploration is proposed to play an important role in practice and development, spending an excessive time stationary for route finding, hold exploration or postural regulation may clearly compromise climbing fluency (Cordier et al., 1993, 1994; Seifert et al., 2014a). Recently, Orth et al. (2017b) suggested the idea that individuals shift toward variables for the perception of affordances that support more fluent climbing, but this hypothesis remains not tested experimentally. Thus, the role that exploration plays in task achievement is not yet fully understood (Seifert et al., 2015). At present, exploration is thought to play a role in climbing but is then believed to decrease once a route is learnt (e.g., climbing fluency improved after six ascents of the same route in Cordier et al., 1993, 1994). However, it is currently unknown how the design of a route (e.g., hold size, distance between holds, hold shape, hold orientation) stimulates exploration during learning and task achievement as previous research (Cordier et al., 1993, 1994, 1996) has not reported the design of the climbing wall (route).

One way to better understand the relation between exploration during learning and task achievement is to vary the route so that learners search for different performatory solutions. Therefore, in the present study, we investigate what affordances an indoor climbing wall offered inexperienced climbers through a learning and transfer protocol with manipulation of the ascending route. The aim of this study was to understand how exploration during learning could help inexperienced climbers to perceive opportunities for action in climbing (i.e., climbing affordances). We hypothesize that, through exploration, climbers learn to pick up informational variables that support behavioral adaptions relative to variations in the design of the climbing route. Specifically, we hypothesize that (i) exploratory behavior should decrease as learning occurs and that (ii) exploratory behavior should be less present in situations affording a single mode of hold grasping rather than multiple modes of hold grasping.

METHODS

Participants

Eight climbers (five males and three females) with a mean age of 21.0 ± 2.4 years; mean height: 167.0 ± 10.8 cm; mean arm span: 168.4 ± 10.6 cm; mean weight: 57.6 ± 8.9 kg participated in the study. Participants had practiced indoor climbing for 2.2 ± 1.1 h per week for 1.1 ± 0.8 years and had a 5c climbing ability on the French Rating Scale of Difficulty (F-RSD) (Delignières et al., 1993), which represents an intermediate level of performance (Draper et al., 2011) and corresponds to the control stage of motor learning (Newell, 1991). The study was carried out in accordance with the recommendations of the guidelines of the International Committee of Medical Journal Editors and written informed consent from all participants was obtained, in accordance with the Declaration of Helsinki. The protocol was approved by a University local ethics committee. Vulnerable populations (e.g., minors, persons with disabilities) were not involved in the study.

Protocol

The learning protocol comprised four sessions, each lasting 1 h and separated by 2 days of rest, that required participants to ascend three different grade 5b routes. All participants had 3 min to preview each route prior to climbing and there was a 4-min rest interval between each climb. The order of routes was randomized. Immediately the fourth session, the participants also completed a transfer test, in which a new (fourth) route was climbed.

Each route was identifiable by color and was set on an artificial indoor climbing wall by three professional certified route setters who ensured that the routes matched an intermediate climbing ability (i.e., physical–technical difficulty grades of 5b on the F-RSD). The three routes had the same height (10.3 m) and they were composed of the same number of hand-holds (20), which were bolted to a flat vertical surface (**Figure 1**).

The holds were located at the same place on the artificial wall for all routes; only the orientation of the hold was changed: (i) the first route was designed to allow horizontal hold grasping (H), (ii) the second route was designed to allow vertical hold grasping (V), and (iii) the third route was designed to allow dual grasping (D), (i.e., both horizontal and vertical hold grasping) (**Figure 2**). Furthermore, the route was set to ensure that the footholds invited a vertical grasping pattern, without preventing a horizontal grasping pattern. The difficulty of the route therefore remained the same as the other conditions (i.e., 5b on the F-RSD), but the complexity of the route path and associated holds was higher. Three professional certified route setters confirmed that the routes were of similar difficulty but varied in complexity of route design.

Each route was top-roped, which meant that the route was climbed with the rope anchored above the climber at all times. Each ascent was preceded by 3 min of route preview, which is assumed to be a key climbing performance parameter (Sanchez et al., 2012; Seifert et al., 2017). No instructions were given prior to the route preview to ensure that the opportunity for pre-ascent visual exploration of the climbing route was the same for all participants.

Participants were instructed to self-pace their ascent, with the following task-goal: find a way to climb the wall as *fluently* as possible, without falling down and by minimizing pauses and changes in body direction (Cordier et al., 1993, 1994, 1996; Seifert et al., 2014a). The instructions were not too specific to ensure that climbing actions—and subsequently any exploratory or performatory behaviors—emerged relative to the task constraints of each condition.

Last, a transfer test was designed as a mix of the three previous routes: the first six holds only invited horizontal grasping, the seven next holds only invited vertical grasping, while the last seven holds invited both horizontal and vertical grasping. This route was designed to assess the capability of the climbers to utilize the grasping patterns that they may have developed during the completion of the three practice routes. Thus, the transfer test should be considered as a whole as a new route where an analysis per section is not meaningful (i.e., each section cannot be analyzed separately). Indeed, considering the concept of "nested affordances," we hypothesized that the holds are not perceived separately (i.e., step by step) but could be perceived as a sequence of possibilities of action (Seifert et al., 2017). It would mean that the current behavior of the climber is linked to where he comes from and where he goes next. Therefore, a fluent climbing would be obtained by fluent transition between holds and not by saccadic displacement resulting from step by step problem solving.

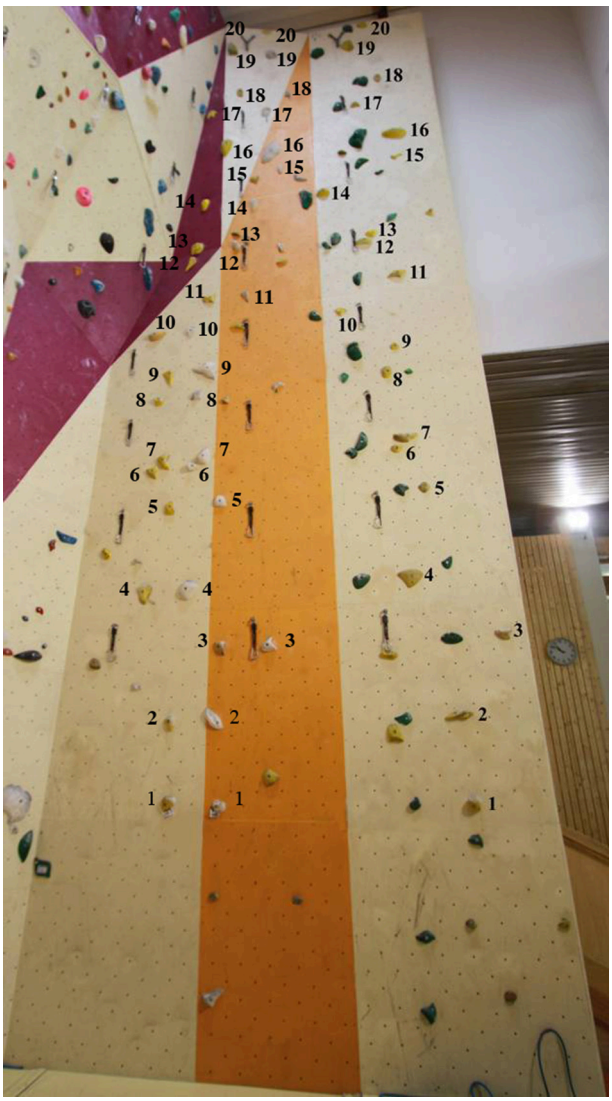

FIGURE 1 | Location of the 20 hand-holds for the three routes. Adapted from Seifert et al. (2015).

Data Collection

Route Difficulty and Design

The difficulty grade of the route was not given to the participants. After the 3 min of route preview, participants were required to estimate the difficulty grade of each route before the ascent. Moreover, how climbers approached the route, in particular how they perceived hold *grasp-ability* and *use-ability* was determined via a modified version of the *presentation*, *approach*, *evaluation* questionnaire (PAE; Sanchez and Dauby, 2009), which focused on the climber's "approach." During the first and fourth practice sessions, perceived hold *grasp-ability* was assessed with the following questions: (a) I easily perceive the holds dedicated for the feet and for hands, (b) I perceive the best manner to grasp the holds; then, perceived hold *use-ability* was assessed as follows: (a)

I easily perceive the movements to do, (b) I easily perceive how to pass from one movement to the next. All answers were given using a 7-point Likert scale (1 = disagree; 7 = fully agree). The estimations of hold grasp-ability and use-ability were then related to behavioral data during the climb.

Behavioral Data

Using a novel method developed by Boulanger et al. (2016), we collected data from the four limbs and hip direction (3D vector in Earth reference frame) using inertial measurement units (IMU) located on the wrists, feet, and the hip (**Figure 3**).

The IMUs combine a tri-axial accelerometer (±8G), a tri-axial gyroscope (1,600°s^{-1}) and a tri-axial magnetometer (*MotionPod*, Movea©, Grenoble, France) and have been used in previous research to assess jerk of the hip trajectory during a climbing task (Seifert et al., 2014a). The outlined configuration of wearable IMUs, with North magnetic reference, was utilized in the current study to record movement data, which was sampled at a frequency of 100 Hz. Wireless transmissions from the IMUs to a controller enabled recording of the movement data through *MotionDevTool* software (Movea©, Grenoble, France).

Data Analysis

Performance Outcome and Climbing Fluency

The performance outcome of each climb was assessed by the number of falls and the ascent duration. Climbing fluency was assessed through the jerk coefficient, which is an indication of the smoothness of hip trajectory (Seifert et al., 2014a). To determine the jerk of the trajectory, the orientation of the sensor is required, first by removing the component due to gravity, since acceleration is measured in the sensor referential, and second, by determining the angular acceleration. By combining the raw data from the accelerometer, gyroscope and magnetometer, it was possible to compute the orientation of the IMU with respect to the fixed frame of reference of the Earth (magnetic North, East and gravity directions; Madgwick et al., 2011). From this point, the acceleration of the hips was computed in the fixed Earth reference frame, and then used to determine the jerk coefficient (for more details about the method and equations, see Seifert et al., 2014a).

For a trajectory $x^{GF} \in C^3$ ($[O, T]$) representing the 3D path of the climber's hips in the time interval $[O, T]$ with respect to the ground frame (GF), the jerk $J_{x^{GF}}$ was defined as:

$$J_{x^{GF}}(T) = C \int_0^T \left\| \dddot{x}_s^{GF} \right\|^2 ds \quad (1)$$

where C is a normalization constant used to make the quantity dimensionless (Hogan and Sternad, 2009), depending on the height and the total climbing time T. In practice, instead of computing x_t^{GF} (position on the wall) from a_t^{GF} with successive integrations, the term $\dddot{x}_s^{GF}$ was replaced by a_t^{GF}. By derivation of a_t^{GF}, the constant gravity acceleration was removed, leaving only the hip acceleration component.

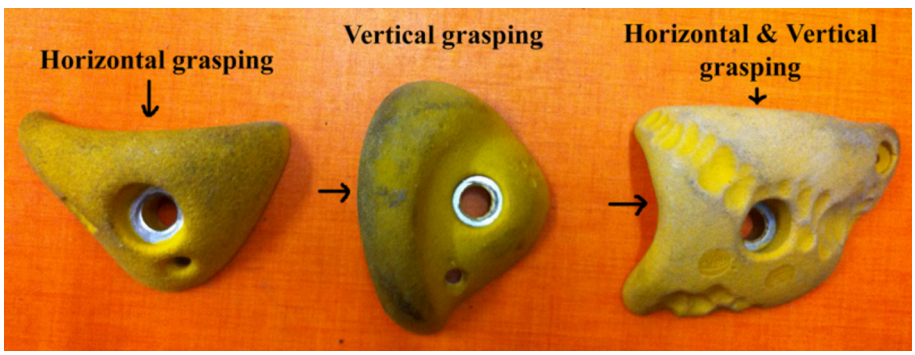

FIGURE 2 | Orientation and shape of the holds for the three routes. The arrow indicates the preferential grasping allowed by the hold. Adapted from Seifert et al. (2015).

FIGURE 3 | Location of the five IMUs on the body.

Climbing Affordances

A multiple sensors-based analysis was conducted to detect the different actions of the climber (Boulanger et al., 2016). Using the data derived from the multiple sensors, five climbing states were identified depending on whether the limbs and/or hip were moving or stationary (Boulanger et al., 2016): stationary (i.e., all limbs were immobile and the hip was immobile), postural regulation (i.e., all limbs were immobile and the hip was moving), hold exploration (i.e., at least one limb was moving and the hip was immobile), hold change (i.e., last hold grasping before body motion), performatory movements (i.e., at least one limb was moving and the hip was moving). The climbing states identified by the method of Boulanger and colleagues were then amended for the purpose of the current study as follows: (i) The *stationary* state represented the state when the climber was not moving at all. She or he might have been resting due to fatigue or might have been looking at the route to determine a subsequent climbing path; (ii) The *postural regulation* state represented an adjustment of the center of mass of the climber while the limbs remained on the same holds. This comprised a body rotation to be able to catch a hold that would not have been reachable from a previous body configuration; (iii) The *hold exploration* state corresponded to the hip remaining stationary while the climber modified the position and orientation of the hands/feet on a hold or performed repetitive movements with one limb to determine which hold to use for the next body motion. These two ways of exploring the holds, which have been characterized as *hold exploratory movements* by Pijpers et al. (2006), were assumed to correspond to a climber's evaluation of the *grasp-ability* of a hold; (iv) The *hold change* state corresponded to the hip remaining stationary while the climber changed the grasped hold before body motion (i.e., *hold transitional* movement); and (v) The *performatory* state represented the state when the climber's hip was moved with concurrent motion of at least one limb, which has been characterized as a hold *performatory movement* by Pijpers et al. (2006), and were assumed to provide an indication of a hold's *use-ability* for the climber.

The relationship between exploratory and performatory movements considered above was used to study how climbers attuned to affordances; that is, how they perceived the climbability of the environment (Boschker and Bakker, 2002; Boschker et al., 2002; Pijpers et al., 2006).

Collectively, the time spent *stationary* and performing *postural regulation* capture a part of exploratory activity that could characterize "route finding" skill, defined as the path followed to perform an ascending climb (Cordier et al., 1993, 1994). In the current study, the "hold change" state was distinguished from the "hold exploration" state because although those limb movements could be exploratory, their results were directly followed by hold utilization. In that case they would be exploratory movements but more skilled because more targeted than others. Interestingly, one could imagine that perceptual learning should not only lead to a decrease of the amount of limb movements performed to explore (i.e., "hold exploration"), but should in fact also consist of a transition from general exploratory behavior ("hold exploration") to more targeted exploratory behavior (thus more often successful, hence often categorized as "hold change"). Thus, "hold change" state could be observed not to decrease with practice. But, at the same time, climbers might also move from a sequential patterning of their movement (e.g., limbs then trunk) to more coordinated movements (yielding a greater fluency), leading to targeted exploratory behavior being categorized as perfomatory.

We hypothesized that the changes in the relative duration (expressed as a percentage relative to the whole climb duration), the number of occurrence of each state (stationary, postural regulation, hold exploration, hold change and performatory movements) were measured during the learning sessions and transfer test. Given our hypothesis that exploratory behavior should decrease as learning occurs, we expected to observe a decrease in the relative duration and the number of occurrences in the stationary and hold exploration states across the practice sessions. If the amount of practice was sufficient, positive transfer can be expected, which means that the relative duration and the number of occurrences in these exploratory states in the transfer test would be similar or lower than in the last training session. Conversely, if the amount of practice was not enough, negative transfer can be expected, which means that the relative duration and the number of occurrences in these exploratory states in the transfer test would be higher than in the last training session. As regards our hypothesis about route design, we expected to observe a lower relative duration and number of occurrences in the stationary and hold exploration states in the H and V routes as compared to the D route.

Statistical Analysis

According to the previous hypotheses, the *effects of practice* and *route design* were analyzed by separate two-way repeated measures ANOVAs (practice across four sessions and climbing wall design across three different routes) for the five states of activity (i.e., number of events and relative duration of stationary, postural regulation, hold exploration, foot or hand changes between two holds, body motion), the number of falls, the ascent duration and the jerk coefficient. Effects of practice and route design were also analyzed by separate two-way repeated measures ANOVAs (practice across first and fourth sessions; and climbing wall design across three different routes) for the perception of the route difficulty (via the four questions of the PAE questionnaire). Sphericity in the repeated measures design was verified with the Mauchly test (Winter et al., 2001). When the assumption of sphericity was not met, the significance levels of F-ratios were adjusted according to the Greenhouse-Geisser procedure. Then, False Discovery Rate (FDR) correction across all the ANOVA condition main effects was done according to Benjamini and Hochberg (1995). Last, *post-hoc* pairwise conditions comparison tests were applied and family-wise error rate was controlled by applying a Bonferroni correction of the p-value (Howell, 2002).

Skill transfer was analyzed for the same dependent variables using one-way repeated measures ANOVA and simple contrast tests. Planned contrast tests were used to examine how practice on *known routes* affected performance on *new routes*, by comparing the fourth session of each route with the transfer test. This contrast test is interesting because as suggested in the

previous section, the amount of practice can have an effect on exploration both for route finding and hold grasping. Therefore, positive effects of exploration would mean that no significant differences in climbing fluency and exploratory behavior would emerge between the fourth session and the transfer test. Partial eta squared (η_P^2) statistics were calculated as an indicator of effect size, considering that $\eta_P^2 = 0.01$ represents a small effect, $\eta_P^2 = 0.06$ represents a medium effect and $\eta_P^2 = 0.15$ represents a large effect (Cohen, 1988). All tests were performed using IBM SPSS Statistics 20.0 (1989–2011), with a level of statistical significance fixed at $p < 0.05$. Except where otherwise indicated, all numerical values in parentheses correspond to the mean and standard deviation.

RESULTS

Effect of Route Design

Performance Outcome and Climbing Fluency

Significant effect of route design occurred for the number of falls [$F_{(2, 6)} = 5.79$, $p = 0.045$, $\eta_P^2 = 0.79$], ascent duration [$F_{(1.39, 6)} = 5.47$, $p = 0.048$, $\eta_P^2 = 0.77$] and jerk coefficient [$F_{(1.44, 10.13)} = 5.84$, $p = 0.027$, $\eta_P^2 = 0.45$]. *Post-hoc* tests revealed that a significantly higher number of falls occurred for the D route (4.4 ± 0.7 falls) than the H route (1.1 ± 0.7 falls, $p = 0.043$) and the V route (0.6 ± 0.5 falls, $p = 0.039$). *Post-hoc* tests emphasized significantly longer ascent duration for the D route (114.5 ± 11.3 s) than for the H route (83.5 ± 8.0 s, $p = 0.003$) but no difference occurred with the V route (96.6 ± 9.4 s). Finally, *post-hoc* tests showed significantly higher jerk coefficient values (i.e., a lower fluency) for the V route ($1.65 \times 10^{13} \pm 5.81 \times 10^{11}$, $p = 0.032$) and for the D route ($2.68 \times 10^{13} \pm 9.74 \times 10^{11}$, $p = 0.028$) compared to the H route ($3.29 \times 10^{12} \pm 1.21 \times 10^{11}$).

Climbing Affordances

Globally, the D route comprised significantly more occurrences of each climbing state (i.e., higher number of periods spent stationary, performing postural regulation, hold exploration, hold change and performatory movements) than the H route (**Table 1**). Moreover, the relative time spent in a stationary state was significantly longer and the relative time spent in the performatory state was significantly shorter in the D route than in the H route (**Table 1**).

TABLE 1 | Effect of route design on the climbing states (i.e., number of events and total relative duration of the state expressed in % of the whole ascent duration).

Route	Number	Relative duration (%)
IMMOBILITY		
Horizontal	19.7 ± 5.0	26.1 ± 5.7
Vertical	27.8 ± 6.2*** $p = 0.012$	31.3 ± 5.1
Dual	30.3 ± 4.3* $p = 0.001$	34.2 ± 4.0* $p = 0.026$
ANOVA *F*-value	$F_{(1.18, 8.29)} = 9.76$	$F_{(2, 6)} = 6.84$
p-value	0.001	0.027
η_P^2	0.92	0.66
POSTURAL REGULATION		
Horizontal	11.8 ± 1.4	5.4 ± 1.0
Vertical	16.9 ± 2.3*** $p = 0.047$	5.8 ± 1.0
Dual	19.4 ± 2.3* $p = 0.007$	6.9 ± 1.2
ANOVA *F*-value	$F_{(2, 6)} = 10.77$	
p-value	0.01	
η_P^2	0.78	
HOLD EXPLORATORY MOVEMENTS		
Horizontal	7.8 ± 2.5	10.6 ± 1.6
Vertical	10.9 ± 3.3	12.0 ± 1.8
Dual	11.3 ± 2.6* $p = 0.016$	11.2 ± 1.4
ANOVA *F*-value	$F_{(2, 6)} = 8.64$	
p-value	0.017	
η_P^2	0.74	
HOLD CHANGE		
Horizontal	6.3 ± 1.2	5.7 ± 1.1
Vertical	8.4 ± 1.6	6.3 ± 0.7
Dual	10.0 ± 1.0* $p = 0.004$	8.3 ± 0.6
ANOVA *F*-value	$F_{(2, 6)} = 18.52$	
p-value	0.003	
η_P^2	0.86	
PERFORMATORY MOVEMENTS		
Horizontal	16.7 ± 1.4	52.2 ± 7.3
Vertical	22.6 ± 2.6	44.4 ± 6.3
Dual	25.3 ± 2.5* $p = 0.005$	39.4 ± 4.7* $p = 0.017$
ANOVA *F*-value	$F_{(2, 6)} = 13.93$	$F_{(2, 6)} = 6.75$
p-value	0.006	0.029
η_P^2	0.82	0.69

**Post-hoc tests showing significant differences between the Dual route and the Horizontal route.*

****Post-hoc tests showing significant differences between the Vertical route and the Horizontal route.*

Perception of Route Approach

A significant effect of route design occurred on the perception of route approach for question 1 (i.e., perception of the holds dedicated for the feet and for hands) [$F_{(2,6)} = 5.65$, $p = 0.047$, $\eta_P^2 = 0.73$], question 2 (i.e., perception of the best manner to grasp the holds) [$F_{(2, 6)} = 5.72$, $p = 0.044$, $\eta_P^2 = 0.77$], question 3 (i.e., perception of the movements to do) [$F_{(2, 6)} = 5.77$, $p = 0.043$, $\eta_P^2 = 0.78$] and question 4 (i.e., perception of how to pass from one movement to the next) [$F_{(2, 6)} = 7.61$, $p = 0.039$, $\eta_P^2 = 0.81$]. In particular, contrast test showed that the D route was perceived significantly harder than the H route concerning question 1 [D route: 3.75 ± 0.45 vs. H route: 4.69 ± 0.48; $F_{(2, 6)} = 11.66$, $p = 0.011$, $\eta_P^2 = 0.62$], question 2 [D route: 3.25 ± 0.49 vs. H route: 4.69 ± 0.32; $F_{(2, 6)} = 6.63$, $p = 0.039$, $\eta_P^2 = 0.55$], question 3 [D route: 3.56 ± 0.41 vs. H route: 4.44 ± 0.44; $F_{(2, 6)} = 7.04$, $p = 0.033$, $\eta_P^2 = 0.51$] and question 4 [D route: 3.37 ± 0.41 vs. H route: 4.12 ± 0.39; $F_{(2, 6)} = 9.02$, $p = 0.02$, $\eta_P^2 = 0.56$].

Effect of Practice and Transfer of Learning

Performance Outcome and Climbing Fluency

The two-way repeated measure ANOVA showed that the number of falls, ascent duration and jerk coefficient significantly decreased with practice (**Table 2**); *post-hoc* tests highlighted that

TABLE 2 | Effect of practice on number of falls, ascent duration and jerk coefficient.

Trial	Number of falls	Ascent duration (s)	Jerk coefficient
1	4.1 ± 1.5	120.8 ± 13.8	$3.07 \times 10^{13} \pm 1.28 \times 10^{12}$
2	2.7 ± 1.1	100.9 ± 10.2	$1.73 \times 10^{13} \pm 9.71 \times 10^{11}$
3	1.4 ± 0.9* $p = 0.034$	87.4 ± 8.8* $p = 0.026$	$9.94 \times 10^{12} \pm 4.71 \times 10^{11}$ * $p = 0.023$
4	0* $p = 0.01$	84.6 ± 6.3* $p = 0.021$	$4.21 \times 10^{12} \pm 2.78 \times 10^{11}$ * $p = 0.02$
ANOVA *F*-value	$F_{(3,6)} = 5.66$	$F_{(3, 6)} = 16.65$	$F_{(1.39, 10.10)} = 5.76$
p-value	0.047	0.04	0.031
η_P^2	0.77	0.85	0.52

**Post-hoc tests showing significant differences with the first trial.*

these differences occurred between practice 1 vs. practices 3 and 4 (**Table 2**). No significant interaction was found between route design and practice effects.

No falls were observed during the fourth climb on each route, although 5.5 ± 2.7 falls did occur during the transfer test [$F_{(1, 7)} = 6.95$, $p = 0.024$, $\eta_P^2 = 0.57$]. Moreover, the one-way repeated measure ANOVA showed a significant effect of transfer on ascent duration [$F_{(1.25, 8.75)} = 5.76$, $p = 0.035$, $\eta_P^2 = 0.46$]; the simple contrast tests highlighted longer ascent duration on the transfer test (132.7 ± 37.1 s) than on the fourth climb of the H route (75.5 ± 19.4 s) [$F_{(1, 7)} = 9.88$, $p = 0.016$, $\eta_P^2 = 0.59$], while no significant difference was found between the transfer test and the fourth climb of the V route (92.4 ± 33.9 s) and D route (94.3 ± 25.1 s). Finally, the one-way repeated measure ANOVA showed a significant effect of transfer on jerk coefficient [$F_{(1.05, 7.35)} = 5.88$, $p = 0.026$, $\eta_P^2 = 0.48$]; the simple contrast tests highlighted significantly greater jerk coefficient during the transfer test ($5.19 \times 10^{13} \pm 2.32 \times 10^{12}$) in comparison with the fourth climb of the H route ($7.05 \times 10^{11} \pm 2.17 \times 10^{10}$), [$F_{(1, 7)} = 5.91$, $p = 0.042$, $\eta_P^2 = 0.51$], while no significant difference occurred between the transfer test and the fourth climb of the V route ($6.91 \times 10^{12} \pm 4.01 \times 10^{11}$) and D route ($5.03 \times 10^{12} \pm 3.29 \times 10^{11}$).

Climbing Affordances

With practice, the climbers significantly decreased the number of occurrences and the relative duration of hold exploration across all routes (**Table 3**).

Figure 4 exemplified for one participant the lower hold exploratory movements for H route than for D route, and the decrease of hold exploratory movements from trial 1 to trial 4.

The one-way repeated measure ANOVA showed a significant effect of transfer on the number of occurrences of exploration [$F_{(1.34, 9.43)} = 6.21$, $p = 0.028$, $\eta_P^2 = 0.64$], postural regulation [$F_{(3, 5)} = 30.98$, $p = 0.001$, $\eta_P^2 = 0.95$], stationary position [$F_{(3, 5)} = 6.63$, $p = 0.027$, $\eta_P^2 = 0.70$] and performatory movements [$F_{(3, 5)} = 6.09$, $p = 0.031$, $\eta_P^2 = 0.78$]. The simple contrast tests highlighted that the transfer test exhibited a significantly higher number of occurrences of exploration [$F_{(1, 7)} = 7.47$, $p = 0.026$, $\eta_P^2 = 0.62$], postural regulation [$F_{(1, 7)} = 21.49$, $p = 0.002$, $\eta_P^2 = 0.75$], stationary [$F_{(1, 7)} = 7.27$, $p = 0.030$, $\eta_P^2 = 0.61$] and performatory movements [$F_{(1, 7)} = 6.49$, $p = 0.038$, $\eta_P^2 = 0.48$] than the H route's fourth training session (**Figure 5**). The simple contrast tests yielded no significant difference for the V and D routes (**Figure 5**). Finally, as observed for the route design effect, the one-way repeated measure ANOVA showed a significant effect of transfer on the relative duration of performatory movements [$F_{(3, 5)} = 10.79$, $p = 0.013$, $\eta_P^2 = 0.87$] and stationary position [$F_{(3, 5)} = 6.85$, $p = 0.036$, $\eta_P^2 = 0.74$]. The simple contrast tests showed

TABLE 3 | Effect of practice on the climbing states (i.e., number of events and total relative duration of the state expressed in % of the whole ascent duration).

Trial	Number	Relative duration (%)
IMMOBILITY		
1	27.9 ± 5.7	31.6 ± 4.5
2	28.4 ± 5.6	28.2 ± 4.8
3	22.5 ± 4.6	32.0 ± 5.0
4	21.3 ± 3.7* $p = 0.028$	30.3 ± 5.9
ANOVA *F*-value	$F_{(3, 6)} = 7.94$	
p-value	0.022	
η_P^2	0.62	
POSTURAL REGULATION		
1	18.0 ± 3.2	6.2 ± 1.6
2	17.3 ± 3.3	7.4 ± 2.1
3	15.3 ± 1.6	5.0 ± 0.9
4	13.6 ± 1.4	5.4 ± 1.1
HOLD EXPLORATORY MOVEMENTS		
1	11.0 ± 2.4	13.3 ± 1.8
2	10.6 ± 3.2	11.0 ± 1.9
3	8.9 ± 2.7	9.3 ± 2.1
4	9.6 ± 2.7	8.1 ± 2.2* $p = 0.037$
ANOVA *F*-value		$F_{(3, 6)} = 7.17$
p-value		0.027
η_P^2		0.66
HOLD CHANGE		
1	8.9 ± 1.4	6.5 ± 0.8
2	7.1 ± 1.1	5.6 ± 0.7
3	9.2 ± 1.4	7.8 ± 1.1
4	8.7 ± 1.3	7.2 ± 0.9
PERFORMATORY MOVEMENTS		
1	23.2 ± 3.5	42.4 ± 5.5
2	22.6 ± 3.2	47.6 ± 5.9
3	21.4 ± 1.2	45.9 ± 4.9
4	19.0 ± 1.3* $p = 0.025$	45.5 ± 6.1
ANOVA *F*-value	$F_{(3, 6)} = 7.08$	
p-value	0.029	
η_P^2	0.65	

**Post-hoc tests showing significant differences with the first trial.*

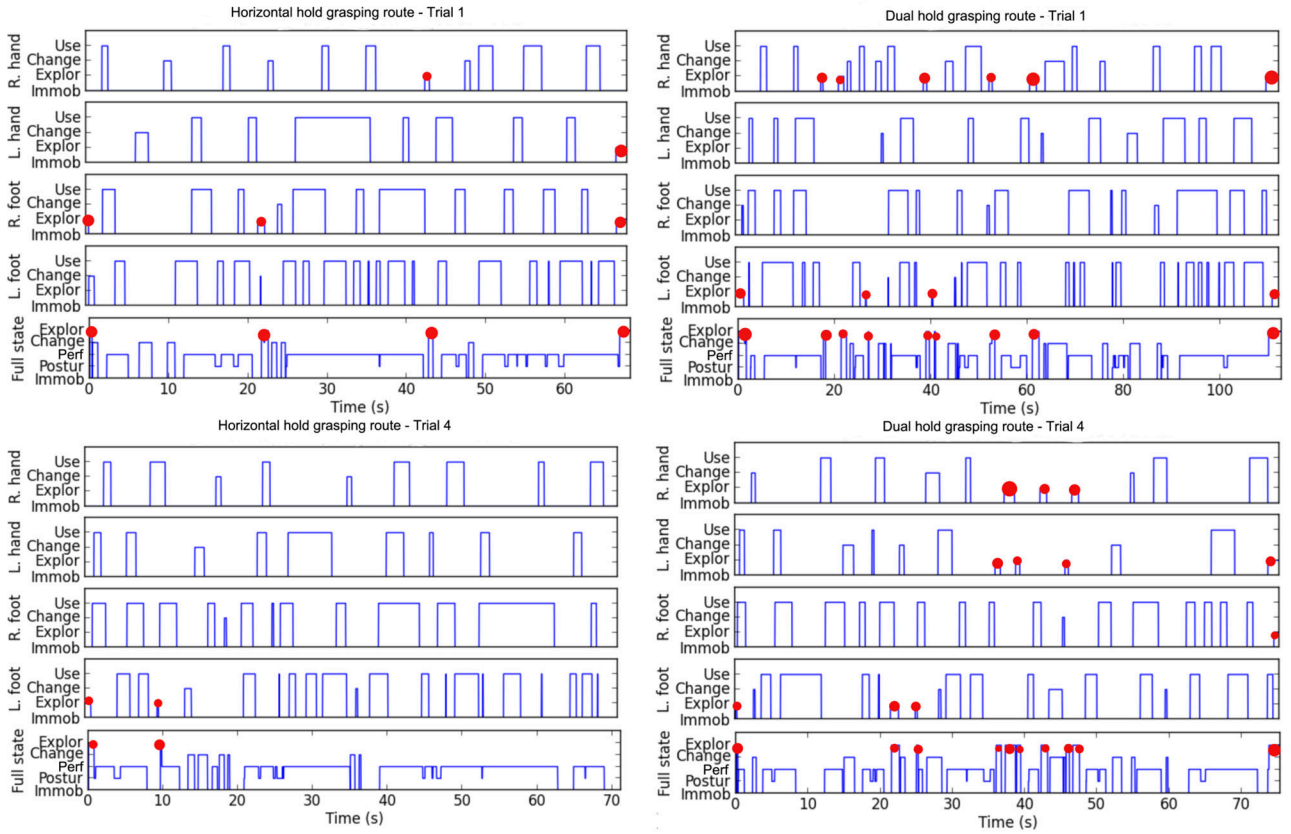

FIGURE 4 | Example for one participant of the climbing states time series for the right hand (R. hand), the left hand (L. hand), the right foot (R. foot), the left foot (L. foot) and the full body state based on the decision tree designed by Boulanger et al. (2016). The four panels exemplified (by red dots) the lower hold exploratory movements on the H route **(Left)** than on the Dual route **(Right)**, and the decrease of hold exploratory movements from trial 1 **(Top)** to trial 4 **(Down)**.

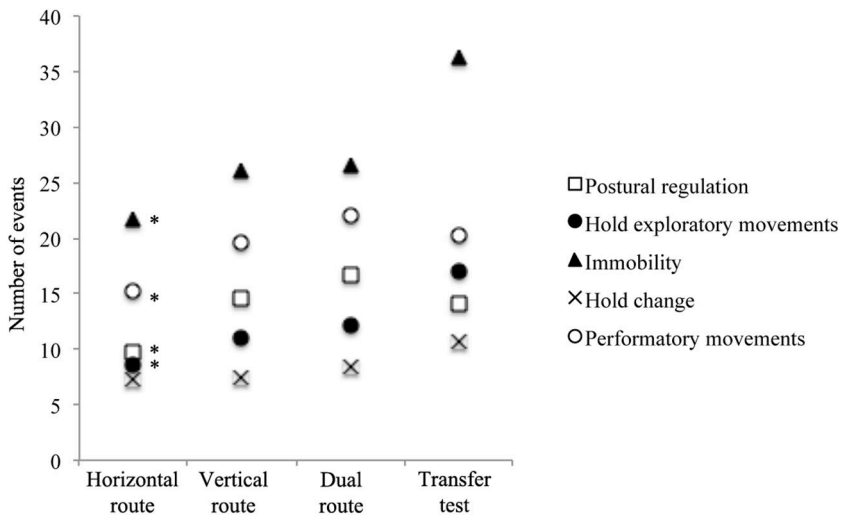

FIGURE 5 | Differences between the transfer test and the three routes performed during the learning protocol concerning the number of events of each of the five climbing states. *Simple contrast tests showing significant differences between the transfer test and the fourth session of each route.

that a significantly shorter relative duration was dedicated to performatory movements during the transfer test than during the fourth training session of the H route [$F_{(1, 7)} = 13.58$, $p = 0.011$, $\eta_P{}^2 = 0.66$], the V route [$F_{(1, 7)} = 14.66$, $p = 0.006$, $\eta_P{}^2 = 0.68$] and the D route [$F_{(1, 7)} = 12.98$, $p = 0.009$, $\eta_P{}^2 = 0.65$] (**Figure 6**). Moreover, the simple contrast tests showed a significantly longer relative duration of the stationary position during the transfer test than during the fourth training session of the H route [$F_{(1, 7)} = 11.39$, $p = 0.012$, $\eta_P{}^2 = 0.62$], the V route [$F_{(1, 7)} = 9.38$, $p = 0.023$, $\eta_P{}^2 = 0.52$], and the D route [$F_{(1, 7)} = 7.15$, $p = 0.032$, $\eta_P{}^2 = 0.47$] (**Figure 6**).

Perception of Route Approach

With practice, the climbers perceived the route approach to be significantly more difficult at session 1 (S1) than at session 4 (S4), for question 1 [S1 = 3.62 ± 0.48 vs. S4 = 4.67 ± 0.43; $F_{(1, 7)} = 32.41$, $p = 0.001$, $\eta_P{}^2 = 0.82$], question 2 [S1 = 3.5 ± 0.32 vs. S4 = 4.58 ± 0.42; $F_{(1, 7)} = 10.65$, $p = 0.014$, $\eta_P{}^2 = 0.61$], question 3 [S1 = 3.16 ± 0.28 vs. S4 = 4.71 ± 0.51; $F_{(1, 7)} = 23.09$, $p = 0.002$, $\eta_P{}^2 = 0.77$], and question 4 [S1 = 2.83 ± 0.31 vs. S4 = 4.54 ± 0.41; $F_{(1, 7)} = 70.46$, $p = 0.0001$, $\eta_P{}^2 = 0.91$]. There was no interaction between the effect of practice and route design, suggesting that the approach of the D route was always perceived harder than the H route. Moreover, as observed for the route design effect, the transfer test was perceived as being significantly more difficult than the three other routes across all four questions (**Table 4**).

DISCUSSION

The aim of the present study was to investigate the role of exploratory behavior in the perceptual attunement of climbing affordances. This was achieved by simultaneously investigating how exploratory behaviors evolved during learning, and how exploratory behaviors differed as a function of the climbers' mastery of the different action modes required across climbing routes with different holds designs. There were therefore two primary perquisites to ascertain for our study: first, whether the participants' performance differed across climbing routes, and second, whether participants' performance improved across learning sessions.

Effect of Route Design

The results revealed a significant effect of the route design as (i) the H and V routes resulted in higher performance outcomes (i.e., less falls and shorter ascent duration) than the D route, and (ii) H route yielded a higher climbing fluency (i.e., lower jerk coefficient) than the D and V routes. The absence of an interaction effect between route design and practice indicated that despite initial differences in performance and climbing fluency levels between the route designs, the way that performance improved with practice did not differ for the respective routes.

In order to explain the changes in performance outcomes between the routes, our main hypothesis was that exploratory and stationary behaviors would decrease as a function of one's mastery of the action mode required for climbing each route. In other words, we hypothesized that more complex route designs would afford less to the learners due to their lower abilities to grasp and to use the holds. The results of the PAE questionnaire suggested that when complex action modes were solicited by the route design, the learners less frequently *perceived the hold grasp-ability* (i.e., which and how to grasp the holds). Specifically, in our study the climbers actualized the vertical hold grasping pattern less frequently than the horizontal hold grasping pattern.

Routes V and D also led to longer relative durations of stationary moments than route H. The longer relative duration of the stationary action mode could reflect periods of visual exploration that were utilized to actively search the climbing wall (Button et al., 2016; Orth et al., 2016; Seifert et al., 2017)

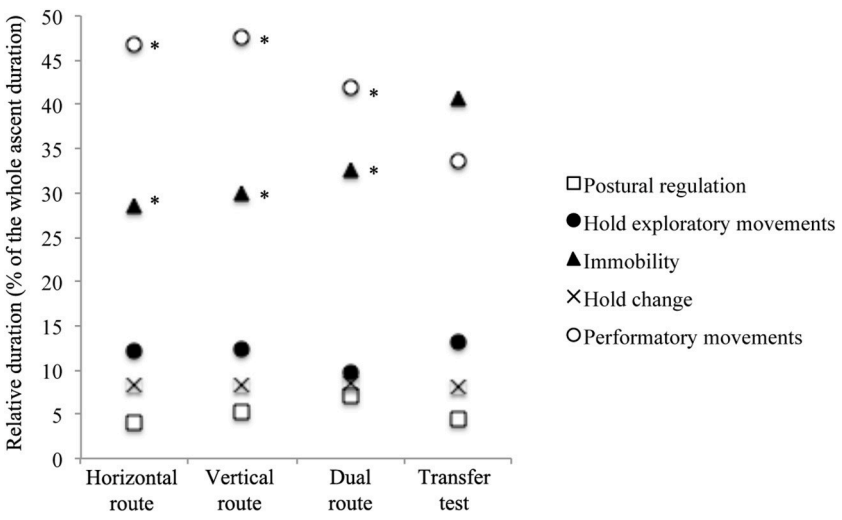

FIGURE 6 | Differences between the transfer test and the three routes performed during the learning protocol concerning the relative duration of each of the five climbing states. *Simple contrast tests showing significant differences between the transfer test and the fourth session of each route.

TABLE 4 | Differences between the transfer test and the three routes performed during the learning protocol concerning the perception of the route approach.

Route	Question 1	Contrast tests
Horizontal	5.2 ± 1.2*	$F_{(1, 7)} = 49.0$, $p = 0.0001$, $\eta_P^2 = 0.87$
Vertical	4.5 ± 1.3*	$F_{(1, 7)} = 28.0$, $p = 0.001$, $\eta_P^2 = 0.81$
Dual	4.2 ± 1.2*	$F_{(1, 7)} = 5.73$, $p = 0.048$, $\eta_P^2 = 0.45$
Transfer	3.5 ± 1.0	
ANOVA *F*-value	$F_{(3, 5)} = 19.1$	
p-value	0.004	
η_P^2	0.92	
Route	**Question 2**	**Contrast tests**
Horizontal	5.3 ± 0.9*	$F_{(1, 7)} = 37.3$, $p = 0.0001$, $\eta_P^2 = 0.84$
Vertical	4.4 ± 1.3*	$F_{(1, 7)} = 10.1$, $p = 0.007$, $\eta_P^2 = 0.68$
Dual	4.2 ± 1.3*	$F_{(1, 7)} = 7.68$, $p = 0.03$, $\eta_P^2 = 0.52$
Transfer	3.2 ± 1.3	
ANOVA *F*-value	$F_{(3, 5)} = 8.96$	
p-value	0.019	
η_P^2	0.84	
Route	**Question 3**	**Contrast tests**
Horizontal	5.0 ± 1.6*	$F_{(1, 7)} = 22.4$, $p = 0.002$, $\eta_P^2 = 0.76$
Vertical	4.8 ± 1.5*	$F_{(1, 7)} = 22.8$, $p = 0.002$, $\eta_P^2 = 0.76$
Dual	4.4 ± 1.5*	$F_{(1, 7)} = 10.7$, $p = 0.014$, $\eta_P^2 = 0.61$
Transfer	3.0 ± 1.1	
ANOVA *F*-value	$F_{(3, 5)} = 7.3$	
p-value	0.028	
η_P^2	0.81	
Route	**Question 4**	**Contrast tests**
Horizontal	4.8 ± 1.0*	$F_{(1, 7)} = 63.0$, $p = 0.0001$, $\eta_P^2 = 0.90$
Vertical	4.5 ± 1.2*	$F_{(1, 7)} = 22.9$, $p = 0.002$, $\eta_P^2 = 0.77$
Dual	4.4 ± 1.5*	$F_{(1, 7)} = 10.7$, $p = 0.014$, $\eta_P^2 = 0.61$
Transfer	3.0 ± 1.3	
ANOVA *F*-value	$F_{(3, 5)} = 20.6$	
p-value	0.003	
η_P^2	0.93	

**significant different with transfer test.*
Simple contrast tests showing significant differences between the transfer test and the fourth session of each route.

and thus might reflect "route finding" skill (Cordier et al., 1993, 1994). Route finding requires the determination of a spatial pathway that enables climbers to link movements in time across a landscape of nested affordances in order to reduce stationary periods during the ascent (Cordier et al., 1993, 1994; Orth et al., 2016). The current results are in line with previous research, which has revealed that when climbers of various skill levels ascend a route, the less skilled climbers use a hold-to-hold approach as they exhibit simple grasping patterns (i.e., dual-hand grasping on a hold) whereas skilled climbers exploit more complex grasping patterns (i.e., arm crossing between holds; see Boschker and Bakker, 2002 for more details), which resonates with the proposal that skilled climbers perceive climbing routes as a *landscape of affordances* (Bruineberg and Rietveld, 2014; Rietveld and Kiverstein, 2014). According to Bruineberg and Rietveld (2014), the concept of a "*landscape* of affordances" aims to capture the interrelatedness of the available affordances. "*Affordances are not encountered as a set of separate possibilities for action, but rather as a nested structure of interrelated affordances*" (p. 3) (Bruineberg and Rietveld, 2014). That is, as suggested by Seifert et al. (2017), skilled climbers appear to perceive a cluster of holds rather than multiple separate holds, suggesting that they perceive one continuous (prospective) opportunity for action.

Further to the longer relative durations of stationary ascent (that we hypothesized to be dedicated to finding the route path), the D route also resulted in a higher number of performatory movements and a shorter relative duration in the performatory state in comparison with the H route. These findings might be due to the fact that there were twice as many possible actions (i.e., dual grasping) offered by the D route holds. Indeed, knowing that each respective route was composed of 20 holds, one might expect that at least 20 performatory movements would occur for each route. However, <20 performatory movements occurred in the H route, which is partly explained by some falls that occurred early in practice, but also, more importantly, because some climbers skipped some of the holds later in practice. Conversely, even when falls are included, the climbers exhibited more than 20 performatory movements on the V and D routes, suggesting that they used dual-hand grasping on one hold. Dual-hand grasping is likely to be commensurate with stationary states and could lead to less fluid actions (i.e., increased jerk) and indicate a lack of *use-ability* (for instance in comparison to a crossed arm movement; Boschker and Bakker, 2002). This point of interpretation reinforces the interpretation that the learners climbed hold-by-hold in more complex routes rather than fluent ascending actions.

Effect of Practice and Transfer of Learning

The results showed a positive effect of practice, as the learners significantly improved the performance outcome (i.e., less falls and shorter ascent duration) and climbing fluency (i.e., lower jerk coefficient) through the four climbs across all routes designs (see Cordier et al., 1994; Seifert et al., 2014a; Orth et al., 2017b). Performance outcomes and climbing fluency were also significantly worse on the transfer test in comparison to the H route. However, there was no difference in total climb duration and climbing fluency between the transfer test and routes V and D. This confirms that climbing a route that invites easier and more conventional action modes (i.e., using horizontal hold grasping pattern) leads to enhanced performance outcomes and climbing fluency. Furthermore, our findings suggest that more practice than four sessions appears to be necessary to develop more complex action modes (i.e., using vertical hold grasping pattern) needed to climb routes that consisted of V and D holds. However, this hypothesis needs to be tested in a future study because the amount of practice was not manipulated in the current study.

To explain these changes of the performance outcome with practice, our main hypothesis was that exploratory, stationary, and performatory behaviors would decrease as learning occurs. With practice, the learners decreased the relative duration of hold exploration, suggesting that they improved their *perception of hold grasp-ability*; that is, they learnt which and how to grasp holds (as also reported by the PAE questionnaire), confirming previous findings (Seifert et al., 2015; Orth et al., 2017a). The absence of a significant difference in relative duration of exploration between the transfer test and the fourth session for the three other routes confirmed this trend.

The climbers also decreased the number of stationary states across learning sessions, suggesting that they became attuned to affordances that supported more fluent climbing (also described previously as improvement of "route finding" skill; see Cordier et al., 1993, 1994 for more details). However, performance on the transfer test led to higher number of stationary states and longer relative duration of stationary state than the fourth sessions of the three routes performed during practice. Taken together, the fact that the improvement of route finding skill and hold grasp-ability perception did not fully enhance performance on the transfer test suggests that the intermediate climbers in the current study might need more sessions of practice and/or sessions involving more variation (e.g., including routes mixing hold types) for a complete positive transfer to occur (for similar hypothesis, see Huet et al., 2011). Future research with higher amount of practice or manipulation of the amount of practice would be necessary to confirm this suggestion.

The number of performatory movements decreased as performance increased during learning sessions, confirming that participants' climbing efficacy improved as a function of practice. In addition, the perception of the route (from PAE questionnaire) also improved with practice suggesting that changes in the performatory movements might reflect *higher hold-use-ability*. The transfer test produced shorter relative durations dedicated to performatory movements than the fourth session of the three routes performed during practice. We interpreted this shorter relative duration dedicated to performatory movements as *lower hold use-ability* because it's associated with a higher number of performatory movements on the transfer test, V and D routes in comparison to H route.

In conclusion, our study emphasized that with practice, climbers learnt to explore as they improved their attunement to affordances and they enlarged their landscape of affordances; in particular, the climbers improved their route-finding skill, hold grasp-ability and use-ability. However, these improvements were dependent on the complexity of the route design as they persisted only on the H route and not the V route, the D route, and the transfer test, suggesting that the learners did not transfer skills to more complex settings. Thus, specific to considerations for the design of climbing practice conditions, these findings indicate that it is crucial to design holds and routes that mirror the complexity of outdoor climbing, but in a manner that invites effective and safe exploration. This is particularly the case in extreme sports such as climbing, whereby learners continuously perform in new, more challenging contexts.

AUTHOR CONTRIBUTIONS

LS, DO, and BM contributed to the experimental design. LS and DO contributed to the data collection. LS, JB, and RH contributed to the data analysis. LS, DO, BM, RH, JB, and MD contributed to the interpretation of the results and the writing.

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Skiing and Thinking About It: Moment-to-Moment and Retrospective Analysis of Emotions in an Extreme Sport

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Happiness is typically reported as an important reason for participating in challenging activities like extreme sport. While in the middle of the activity, however, participants do not seem particularly happy. So where does the happiness come from? The article proposes some answers from a study of facially expressed emotions measured moment-by-moment during a backcountry skiing event. Self-reported emotions were also assessed immediately after the skiing. Participants expressed lower levels of happiness while skiing, compared to when stopping for a break. Moment-to-moment and self-reported measures of emotions were largely unrelated. These findings are explained with reference to the Functional Wellbeing Approach (Vittersø, 2013), which argues that some moment-to-moment feelings are non-evaluative in the sense of being generated directly by the difficulty of an activity. By contrast, retrospective emotional feelings are more complex as they include an evaluation of the overall goals and values associated with the activity as a whole.

Keywords: emotions, facial expression, moment-to-moment, functional wellbeing approach, extreme sport, backcountry skiing

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INTRODUCTION

We engage in recreational activities in order to feel good. This pursuit is not restricted to leisure activities like sunbathing at the beach or enjoying a fine meal with friends and family. Mountaineers, BASE jumpers, and other extreme athletes also claim that the importance of their favorite activities is the experience of positive feelings (Brymer, 2005; Willig, 2008; Brown and Fraser, 2009; Hetland and Vittersø, 2012). But what exactly is it that feels so good about these vigorous and exhausting activities, often referred to as extreme sport? To explore this question, we developed a new way of measuring emotions in real time during the activity. We equipped the participants with a camera that captured their facially expressed emotion while skiing. These films were then analyzed with software for automatic coding of facial expressions and compared the participants self-reported emotions assessed in retrospect. This approach enabled us to explore long standing questions as to how such positive experiences are created. Are they a result of a series of online positive feelings? Or is it the impact of a few central features like intensity peaks, rapid emotional changes, and happy endings that create them? Is it the experience of flow? Or is it the feeling of mastery that kicks in only after the activity has been successfully accomplished?

The present study explores these questions in order to enhance our understanding of the somewhat puzzling reports from extreme sport athletes about feeling good while performing activities like backcountry skiing, that appear—on the surface—to be extremely strenuous and highly unpleasant. We start with a brief clarification of the terminology regarding extreme sport.

Extreme Sport

The term extreme sports covers a wide range of mostly individualized activities which are becoming increasingly popular in the western world (Thorpe and Wheaton, 2013; Brymer and Houge Mackenzie, 2017). Despite the significant growth in participants, media coverage, and research, it seems difficult to reach a clear-cut definition of what extreme sport is, or which activities fall under its umbrella. The term is often used interchangeably with other terms like action sport, adventure sport, lifestyle sport, alternative sport, and also adventure tourism (Puchan, 2004; Brymer and Schweitzer, 2013).

The label extreme sport is often defined as recreational physical activities that carry a risk of serious physical injury or even death (Willig, 2008; Haegeli and Pröbstl-Haider, 2016; Brymer and Schweitzer, 2017). This definition includes activities like BASE jumping, skydiving, hang gliding and paragliding, mountain climbing, surfing, white water kayaking, mountain biking, and backcountry skiing. However, Brown and Fraser (2009) argue that there has been a misconception in the literature. Even though many of these activities inherently involve some level of risk, risk itself is not a main motive. Woodman et al. (2010) argue that there is a considerable diversity among these activities across a range of measures. For example, Barlow et al. (2013) demonstrated that skydiving is strongly associated with sensation seeking, mountaineering on the other hand is not associated with sensation seeking, but rather emotion regulation and agency.

However, even though the activities under this umbrella differ substantially, they share one important feature. These activities allow the participants to create an optimal level of challenge where they are able to stretch themselves toward the edge of their skills while simultaneously insisting on doing so within the limits of their capabilities (Celsi et al., 1993; Larkin and Griffiths, 2004; Willig, 2008; Brymer and Gray, 2009; Kerr and Houge Mackenzie, 2012; Brymer and Schweitzer, 2013). According to Willig (2008), the motivation seems to be twofold. First, it includes a rational and functional motive where participants seek to increase their levels of skill and mastery. Second, participants are motivated to repeat activities that produce positive emotions.

The Feeling of Skill Development

Most skills will not develop unless they are practiced. However the psychological literature diverges when it comes to how such training is experienced. One tradition, going back to Aristotle, will have it that skill development feels good if executed according to certain principles. Different versions of this approach are found in the Eudaimonic identity theory (Waterman, 2008) and flow theory (Csikszentmihalyi, 2009) Self-determination theory (Deci, 1975; Deci and Ryan, 1985, 2000) and the Functional wellbeing approach (Vittersø, 2013, 2016, 2018). The competing position argues that the development of talent requires considerable concentration and effort, and consequently, that the training of skills does not feel good. Ericsson and his colleague are proponents of this view (Ericsson et al., 1993).

Ericsson and his colleagues argue that skills do not develop from enjoyment, but from deliberate practice (Ericsson et al., 1993). Not unlike the preconditions for flow, deliberate practice requires clear feedback, possibility for repetition, correction of errors, and a task at an appropriate level of difficulty. However, in contrast to flow, Ericsson argues that this process of developing skills into excellence requires considerable efforts and is not inherently enjoyable.

This assumption is supported by several studies that demonstrate that flow is not an optimal experience, at least not in the sense of being enjoyable, and, at the same time contributing to the development of skills. Schüler and Brunner (2009) for example, found that during a marathon race, flow was not associated with better performance. Another study compared amateur and professional singers and found that the amateurs put less effort into their rehearsals and reported more enjoyment while singing (Grape et al., 2002).

Eudaimonic identity theory suggests that people typically feel good when their true potential is realized. According to Waterman (2008) these experiences are often described as "feeling really alive" or "feeling fulfilled." Flow theory also suggests a link between optimal experience and optimal functioning where "the person feels simultaneously cognitively efficient, motivated and happy" (Moneta and Csikszentmihalyi, 1996, p. 277). In order to experience a state of flow, three conditions are especially important. These are: clear goals, immediate feedback, and a balance between perceived challenge and perceived skill (Csikszentmihalyi, 2009, pp. 397–398). If these are present, they might lead the actor to experience a merging of action and awareness, a sense of control, an altered sense of time and loss of self-consciousness.

Self-determination theory (SDT; Deci, 1975; Deci and Ryan, 1985, 2000; Ryan and Deci, 2017) is a widely cited theory about human behavior and personal development. Grounded in an organismic approach to the understanding of human nature, the SDT claims that humans are intrinsically motivated by "default." Unless interrupted by an external motivation or a wish to experience strong, positive affect, humans will continuously do things they expect will satisfy three basic psychological needs. The needs are feeling competent, feeling self-determined (autonomous) and feeling related. People will typically experience these feelings in challenging situations, and that is why they often seek out situations that are challenging. According to SDT then, an activity such as backcountry skiing will be initiated by persons who expect that this activity will provide them with feelings of competence, self-determination and relatedness. When these feelings are experienced, their basic psychological needs are fulfilled.

Hence, SDT offers an explanation of why people engage in behavior such as backcountry skiing, but not of how feelings in and by themselves can be motivating. Neither does it provide a systematic account of feelings other than those

related to competence, autonomy and relatedness (including the satisfaction that these feelings elicit), nor any details about the structure and functions of such feelings.

The Functional wellbeing approach (FWA; Vittersø, 2013, 2016, 2018) offers such an account, and a brief resume will be given below. The interested reader is referred to Vittersø (2018) for further details.

In order to explain the structural, functional and motivational qualities of activity-related feelings, FWA draws on three major strands of research. One is from Piaget and his concept of functional meaning (e.g., Piaget, 1952) What Piaget meant by functional meaning was, in short, that being active is an innate predisposition in any living organism. A biological structure, by virtue of being alive, encompasses the inclination to exercise its own structure. To operate is part of the structure itself and no further mechanism, like a need or other "energizers," is required to explain why it becomes active.

The second major influence comes from Scheme theory (Eckblad, 1981) which offers a comprehensive account of intrinsic motivation. It is grounded in the work of Piaget, including his notion of the novelty principle. Piaget's novelty principle states that humans are typically attracted to stimuli and environments that are somewhat novel and complex. In terms of cognitive processing, such environments will not be easily assimilated into existing schemas—rather, they *resist* assimilation. Eckblad took this idea one step further, by combining it with the Wundt curve, i.e., the idea that pleasure is related to arousal in a curvilinear manner. The two principles enabled Eckblad to develop a multi-curve model in which distinct feelings reached their most intense expressions at increasingly higher levels of assimilation resistance. Thus, each feeling state has "a single-peaked preference function for any given complexity dimension" (Eckblad, 1981, p. 97). Accordingly, when we are in a familiar and low-complex environment, our feelings will typically be experienced as calm, pleasant, and satisfactory. As the level of assimilation resistance increases, the qualities of the feelings will change toward happiness and joy. The experiences generated by even higher levels of assimilation resistance include feelings of interestingness and challenge. Still higher levels of assimilation resistance produce feelings like frustration or fear, and at that point, the activity is no longer intrinsically motivated.

The third relevant element of the FWA comes from mainstream emotions theories such as the Communicative Theory of Emotions (Oatley and Johnson-laird, 1987; Oatley, 1992) and appraisal theories (Smith and Ellsworth, 1985; Lazarus, 1991; Scherer et al., 2001). These theories hold the view that emotions are evaluative responses to challenges or opportunities regarding goals that are important to us. These appraisal-based emotions will typically occur in conjunction with evaluations of goal status. For instance, happiness will be felt when a goal or a sub-goal is reached, whereas sadness occurs when an important goal (i.e., something valuable) is lost, or when a major plan has failed. The FWA accepts these explanatory principle of emotions, but it suggests that a different kind of feeling exists, as well those generated according to the principles laid out in Eckblad's multi-curve model.

Moment-to-Moment vs. Retrospective Emotions

Early emotion theorists did not make a sharp distinction between moment-to-moment feelings and the memory of these feelings, and retrospective happiness was seen as nothing but accumulation of moment-to-moment pleasures (e.g., Edgeworth, 1881). Happiness in a certain time interval could therefore be quantified as the temporal integral of the experienced pleasure (net of pain) during that event or episode. Despite its controversial content, respected scholars have adopted the essence of this idea (e.g., Cabanac, 1992; Parducci, 1995; Kahneman et al., 1997; Kahneman, 1999).

Although supportive of the idea that feelings can be measured on a moment-by-moment basis, Kahneman has never argued that a mere adding up of such on-line feelings is equivalent to the mental image we store in memory to represent the emotional quality of the time interval in question. Rather, he introduced a distinction between moment-to-moment feelings, or the experiencing self, and memories of that feeling—the remembering self. In an impressive series of studies, Kahneman and his colleagues have documented how remembered feelings do not amount to the sum of the moment-by-moment experiences during an event or episode (Kahneman et al., 1993; Kahneman, 1999; Schwarz et al., 2009; Kahneman and Deaton, 2010).

These studies show that instead of an accumulation of moment-to-moment feelings, the memory of these feelings is created based on the emotional experience at certain key points like beginning, end and emotional peaks during the experience. Features like duration of the experience have been found to have little or no impact on the retrospective evaluations (Fredrickson and Kahneman, 1993). In line with relevant literature, we refer to these key point as gestalt characteristics (Ariely and Carmon, 2003).

A different view on the discrepancy between moment-to-moment feelings and retrospective memories comes from research on flow (Csikszentmihalyi, 1975, 1999). The experience of flow is characterized by enjoyment. However, during intense experiences of immersed and concentrated attention, people may be so absorbed in what they are doing that they do not consciously register the stream of experiences that are created by the body's feeling system. The feelings only surface after the experience is over.

In contrast to flow theory, the FWA argues that people do indeed have intense feelings during flow, but not of enjoyment. Rather, feelings like interest, engagement and immersion comprise the prototypical phenomenology of a flow experience. Emotional feelings such as happiness may come afterward. The reason is, according to the FWA, that moment-to-moment feelings are integrated in the executive part of an activity, whereas the emotional feeling is part of the evaluative part of the activity. The separation of activities into an executive part and an evaluative part owes to the idea of Test-Operate-Test-Exit (TOTE) sequences described by Miller et al. (1960).

In the TOTE model, an activity is characterized by rapid shifts between operating and evaluating the outcome of the operation against the goal for the activity. Following the FWA, both the operating phase and the evaluative phase generate feelings, but

according to different mechanisms. The feelings produced by the operating phase are determined by how difficult the activity is. If the task is too easy, we feel bored. At somewhat higher levels of difficulty we feel pleased, and as the difficulty level increases we feel interested and challenged, until the difficulty become too overwhelming, in which case the feelings become negative, like frustration, anger or fear. The idea about how difficulty and feeling states are associated is adopted from Eckblad (1981).

In phases of evaluation, the prospect of goal achievement regulates the emotional qualities, in line with the principles laid out in the Communicative Theory of Emotions (Oatley and Johnson-laird, 1987; Johnson-laird and Oatley, 1989; Oatley, 1992). Here it is proposed that emotions are responses to challenges or opportunities regarding goals that are important to us. Sadness, for instance, will typically occur when a major plan fails or an important goal (i.e., something valuable) is lost. Happiness, on the other hand, will be felt when a goal or a sub-goal is reached.

The above account of how variations in perceived difficulty create moment-to-moment feelings of different phenomenological qualities on the one hand, and how such moment-to-moment feelings interact with evaluative emotions on the other, resembles an explanation offered by Buckley (2016).

Buckley's work concerns the interplay between fear and thrills. Based on data from more than 4000 participants collected across a range of risk related outdoor activities and measured with different methods he has identified a pattern of subjective experiences referred to as a "sawtooth relation between fear and thrill." Buckley's analysis shows how perceived danger generates a focused awareness, and that this, in turn, may suppress fear and other emotions during phases of intense concentration.

The sequence of a high-risk activity then unfolds by moments of focused attention "during the action or event, then thrill, relief, or triumph afterward. The emotionless state persists only during the most intense concentration." (Buckley, 2016, p. 1). The author also describes a curvilinear relation between perceived risk and thrill. Below a certain threshold of risk, thrill can occur without fear, but when the perceived risk increases, feelings of fear will kick in. As the experience of fear increases, so does the feeling of thrill. However, above some upper threshold thrill vanishes, whereas fear remains. Buckley also noted an adaptation effect, in that the highest levels of fear were reported by first time participants during unfamiliar activities, but the feeling decreased as the experienced increased.

In order to investigate the role of feelings in motivation and skill development, both the level of difficulty and the evaluation of goal status must be considered. An important aim for the present study was to explore how the two principles operate during highly challenging activities such as extreme sport. However, before we proceed to investigate this aim further, a note on terminology is in order.

The paper operates with three levels of time segments. We use the term *event* for the entire happening under investigation, i.e., from when the skiers start at the top of the mountain until they end at the parking lot. The term *episode* is used for the next level, where the event is divided into seven smaller parts, like (1) at the top, one minute before start, (2) the first part of the descent, (3) before half-way, (4) half-way down the mountain, (5) after half-way, (6) last part of the descent and (7) immediately after stopping. The final time segment is referred to as *moment-to-moment experiences* or *moment-by-moment experiences*, which are used synonymously. A moment-to-moment experience is an ongoing emotional experience captured in real time. Finally, we will refer to the phenomenological aspect of an emotion as a subjective experience or, as a synonym, a feeling state.

Measuring Emotions

The most common way to measure emotions is through various types of self-reports. However, in addition to the obvious challenges of reporting one's emotions while skiing, putting experiences into words demands at least some level of cognitive reflection. Thus, if the participants are totally immersed, reporting emotions will be impossible (Nilsen and Kaszniak, 2007).

Some people will even have a hard time identifying and describing their emotions regardless of their level of activity. Such difficulty is called alexithymia and a recent study show that this deficit is connected to greater risk-taking (Barlow et al., 2015).

Kahneman and Riis (2005) have argued that when properly validated, physiological measures like Electroencephalography (EEG), heart rate or skin conductance level would offer an uninterrupted moment-to-moment report of emotions. But, at least in the case of extreme sport which almost always involves physical activity, the activity itself will create a considerable amount of noise, rendering it impossible to disentangle the effect of psychological activity expressed physiologically, from the mere physical activity itself. In addition, there are issues of translating these somatic measures into what they really mean in terms of psychologically experienced emotions.

Systematic observations of facial expressions of emotions offer another source of information about subjective experiences. According to Matsumoto et al. (2008), facial expressions are (1) universal and reliable indicators of discrete emotions which (2) co-vary with subjective experiences and (3) are a part of a coherent package of emotional responses that include appraisals, physiological reactions, and other nonverbal behaviors and subsequent actions. There is strong support for at least six universal facial expressions communicating happiness, fear, sadness, disgust, anger and surprise (Ekman, 1993). However, new studies suggest that as many as eight different positive emotion are associated with distinctive expressive displays. In addition to happiness, these emotions are amusement, awe, contentment, interest, joy, love and pride (Campos et al., 2012).

Observing participants facially expressed emotions has previously been tested as a way of capturing extreme sport experiences. Buckley (2016) observed or collected films of more than 4000 participants while performing different risk related activities. The results revealed a substantial variation in emotions. Unfortunately, none of the raters were trained in coding facial expressed emotions, and the author were unable to conduct any fine-grained analysis of emotions. This paper follows a similar approach but relies on a sophisticated method for analyzing facially expressed emotions through automatic facial coding (AFC) software.

To perform a reliable measure of facial expressions, Ekman and Friesen (1978) developed the facial action coding system (FACS) which is a way of directly measuring movements of the face. FACS consists of 46 action units, each representing an independent motion of the face, which, in turn, is combined in various ways into distinct facial expressions. A happy facial expression is, for example, indicated by a raised chin, measured by action unit six (AU6) and lip corners pulled upward (AU12). A sad facial expression is, on the other hand, characterized by raised inner brows (AU1), lowered brows (AU4) and depressed lip corners (AU15). However, interest, as described by Campos and his colleagues, is described by the same initial two action units (AU1 and AU4). What distinguishes facially expressed sadness from interest is that instead of depressed lip corners, an interested facial expression sometimes involves compressed lips (AU24) and raised outer brows (AU2).

In the past, the analysis of facial expressions had to be done manually. However, with advances in technology, this can now be done electronically. AFC has several advantages and a few disadvantages compared to manual coding. First and foremost, automatic capturing, interpreting, and coding demands very little labor. In addition, different studies have shown that such digital analyses outperform non-expert coders, and are approximately as accurate as expert coders (Bartlett et al., 1999; Terzis et al., 2010; Lewinski et al., 2014). In a reliability study, Lewinski et al. (2014) found that FaceReader, the software used in this study, recognized 88% of the targeted emotions in both the *Warsaw Set of Emotional Facial Expression* (WSEFEP; Olszanowski et al., 2014) and the *Amsterdam Dynamic Facial Expression Set* (ADFES; van der Schalk et al., 2011). The corresponding number for human raters was 85%. For happiness, the average FaceReader recognition score for the two picture databases was 96%, the corresponding score for human raters was 89%.

On the downside, the methods for coding facial expression are still developing, particularly in how they distinguish the display of different positive emotions (see for example Campos et al., 2012). It takes time before enough pre-coded material is available for a potential update of the computer model used by the AFC programs. In addition, humans are able to code other movements and body postures that the software is not currently able to read. Therefore, happiness is so far the only positive emotion included in the automatic analyses of facial expressions.

Still, the advantages of automatic coding in most cases outweigh the cost, making this method increasingly popular. It has previously been used in a number of fields like emotion science (Bartlett et al., 1999; Chentsova-Dutton and Tsai, 2010), educational research (Terzis et al., 2012, 2013; Chiu et al., 2014), human-computer interaction (Cohen et al., 2003), consumer behavior (Garcia-Burgos and Zamora, 2013; Danner et al., 2014; de Wijk et al., 2014), user experience (Goldberg, 2014), clinical investigations of facial nerve grading in medicine (Dulguerov et al., 1999), monitoring pain (Lucey et al., 2012) and reaction to advertisement and commercial films (Teixeira et al., 2012; Hetland et al., 2015). With video cameras for capturing facial expressions becoming increasingly better and smaller, this method can now be applied in new areas of investigation like extreme sports.

In the current study, we equipped participants with cameras in order to capture their facially expressed emotions while they skied. In addition, we asked them to report the same emotions in a self-report questionnaire immediately after the trip was over.

Aims of the Study

The overarching aims of this study are to test a new method of measuring emotions in the field and use this method to investigate (1) how moment-to-moment feelings unfold during an extreme sport event and (2) how they are related to the emotional self-report presented at the end of the event. Based on these aims, three hypothesis and two research questions were put forward.

Hypotheses:

(1) Given the difficulty involved in backcountry skiing, and the rewarding role played by hedonic feeling when goals and sub-goals have been achieved, we refer to the FWA and predict that participants will be happier when they stop skiing, than when they are actively downhill skiing.
(2) Following the FWA, we hypothesize that there will not necessarily be a strong relationship between the moment-by-moment emotions experienced during a difficult event and the emotions reported from the overall event. This is so because the two kinds of emotions are generated by different mechanisms.
(3) Following the principles presented above as the gestalt characteristics of remembered emotions, we hypothesize that moment-to-moment emotions at key points, like the beginning and the end will predict self-reported event emotions.

We also put forward two research questions, for which the theories presented above give no reason to deduce clear hypotheses.

(1) What is the relationship between facially expressed emotions and the self-reported emotions for the 7 episodes of the event?
(2) What are the similarities and differences between pleasure, interest, and fear across the 7 episodes?

MATERIALS AND METHOD

Participants

Fifty-three backcountry skiers (34 men and 21 women) were recruited through social media and snowball sampling. Age ranged from 19 to 46 (M = 27.51, SD = 5.7). The large majority of the sample was Norwegian (n = 50) but also included skiers from Sweden (n = 2), United States (n = 1), Canada (n = 1) and Germany (n = 1).

Procedure and Materials

The data for this study came from six different sources: Three self-report questionnaires, a computer-based analysis of facial expressions, heart rate measures and speed measures recorded during a skiing event. The questionnaires assessed

(1) background variables (questionnaire A); (2) state emotions immediately after the trip (questionnaire B). A subsample also received (3) a follow up questionnaire 1 week after the trip (questionnaire C) assessing their memory of the trip and appurtenant state emotions. These questionnaires were available in Norwegian and English and were translated and back-translated to ensure equivalence across languages and cultures.

Moment-to-moment emotions were measured with (4) software that analyzed facial expressions. In addition, we also recorded the participants (5) heart rate (HR) and (6) speed.

In the present article, we have focused on data collected during the event (facially expressed emotions) and self-reported emotions immediately after the trip (questionnaire B). In addition, we have used GPS speed to code when the participants are skiing or taking a break.

On the day of skiing, the participants met the researchers in a parking lot at the foot of the mountain to be skied that day. The participants had freely chosen which mountain to go to, which route to take and run to ski. After signing an informed consent form, the participants were each given a ski-helmet. There were five helmets available with two cameras each.

The mounting for the camera is constructed such that it will not swing down and hit the participants face, but rather swing to the side, up or fall of. We demonstrated this feature to the participants and they all got to study the helmets before start of the trip and could wear them on their way up – or take short trial runs if they liked. They were of course also free to remove the camera at any time if they liked, but nobody did. We also asked the participants immediately after the trip about their experiences of skiing with this camera. All participants, with no exception, reported that they habituated quickly and for the most forgot about the camera.

The first camera was attached to the helmet by the skier's ear in order to film the descent from the skier's point of view. The other camera was mounted in front of the skier's face in order to capture his or her facial expressions during the ski (see image below). Each participant was also equipped with a heart rate monitor that recorded speed based on GPS coordinates. At least one researcher accompanied the participants the whole trip. Before they started hiking up, the researchers explained that they would not state any opinion on matters concerning route planning or avalanche safety, though they would take a different route than the skiers if it was determined that the chosen route appeared too dangerous. Aside from that, the researchers interacted with the participants during the whole trip as another member of the ski party. The region where these data were collected has a vast number of mountains typically ranging from 800 to 1200 meters above sea level with very little forest. The typical accent/decent was 600–800 meters of altitude gain/loss.

At the top of the mountain, the participants geared up with cameras and heart rate monitors. The researchers synchronized the two cameras and HR monitor for each skier. The participants then skied at their own pace down the mountain. Immediately after the skiers returned to the parking lot, the researchers distributed a second questionnaire (questionnaire B) that the skiers filled out immediately.

FIGURE 1 | The helmet and cameras used for collecting data. Written informed consent has been obtained from the participant for the publication of this image.

Facially Expressed Emotion

The Camera

The facially expressed emotions were captured with GoPro 4 cameras set to full HD (1080) progressive, a frame rate of 25 images pr. second and field of view (FOV) set to medium. Based on these settings the film consists of 25 self-contained still images pr. second where the entire face of the participants was visible. **Figure 1** shows how the camera was mounted on the helmet.

The Technique

The film was then analyzed using FaceReader v5.0 (Noldus, 2014a). This computer software bases its interpretations and coding's on the FACS (Ekman and Friesen, 1978) for scoring facial expressions. To be able to automatically read facial expressions, the software creates a 3D model of a human face. This model consists of a mesh with 491 measuring points that uses an algorithmic approach to code movements based on the active appearance method (Cootes and Taylor, 2004). The model has been trained on approximately 10,000 images scored by certified FACS experts.

The raw data from FaceReader were then imported to Observer XT v12 (Noldus, 2014b). The data were thereafter synchronized with the films from the two cameras as well as the heart rate and speed data. Based on the two camera angels and speed data, each participant's behavior was coded into skiing and breaks. Breaks were defined to be complete stops of at least a 10-s duration or times when the participants moved so slowly that they needed to use their ski poles to move forward.

The Variables

The AFC software detects the face, applies and adapts the mesh to the individual's features, and by measuring the ongoing movement between the points, it automatically classifies facial motion into the six basic emotions of happy, sad, angry, disgust, fear and surprise, all scored on a scale from 0 to 1. In addition, a neutral state is also recorded. These emotions are not mutually exclusive, meaning that several emotions may register at different

magnitudes at the same time. The film was analyzed frame by frame, providing us with 25 measures every second that captured the intensity and duration of each of the six basic emotions and the neutral state during the whole descent.

Self-Reported Emotions

Self-Reported Emotions for the Entire Event

Immediately after the downhill run was completed, the participants reported on their experience of five basic emotions. We refer to these measures as self-reported event emotions. The five emotions were (1) happiness (measured by the three adjectives happiness, pleasure and satisfaction), (2) interest (measured by the three adjectives interest, engagement, and enthusiasm), (3) fear, (4) anger, and (5) sadness. Each of the three negative emotions were measured with one item each (the adjectives fear, anger and sadness). The items were presented with the introduction: "Now, let us look at your total experience of skiing down the mountain. There are a number of emotions you may have experienced, to a varying extent. Try to recall how you felt while you were skiing, and check the number that best describes your emotions. Note that you have to answer the first nine questions to be able to proceed." For each item, the participants responded using an end-point labeled rating scale ranging from 1 (Not at all) to 7 (Very much).

Because the main interest of the present work was toward positive feelings, we sampled these with multi-item scales. The three happiness adjectives were collapsed into a mean-score happiness variable [Cronbach's alpha (α) = 0.91]. The three interest adjectives were lumped into a mean-score interest variable (α = 0.79). When the six items were fitted to a two-factor confirmatory factor analytic model (CFA), an acceptable fit was returned, $\chi^2(8, N = 36) = 14.59$, $p = 0.068$. This chi-square was a significantly better than that from a one-factor model $\Delta\chi^2(1) = 5.74$, $p = 0.017$. As a kind of robustness test of the two-factor structure for positive emotions, an additional CFA was performed on six emotion items from the European Social Survey ($N = 42648$). We used data from wave 6, since it contains a wellbeing module that includes emotion questions about happiness, enjoyment and calmness (as indicators of happiness) and items on interestingness, absorption and enthusiasm (as indicators of interest). Again, the CFA supports the notion that these six items belong to two different dimensions of positive emotions. The difference in goodness-of fit between the one-factor model and the two-factor model was highly significant, $\Delta\chi^2(1) = 27024$, $p < 0.001$.

Self-Reported Emotions for the 7 Episodes

Self-reported episode emotions were also measured immediately after the activity. The participants reported their level of pleasure, interest, and fear at seven different stages of the descent, from (1) at the top, one minute before start, (2) the first part of the descent, (3) before half-way, (4) half-way down the mountain, (5) after half-way, (6) last part of the descent and (7) immediately after stopping. The items were presented with the introduction "Below you will find a graph with a time line (horizontal) and a "feelometer" scale on the vertical axis, ranging from 0 (not pleasant/ not interesting/no fear) to 10 (very pleasant/ very interesting/ very much fear). We want you to state how much (pleasure/interest/fear) you experienced at the different parts of the ski trip from when you stood at the top until you stopped at the foot of the mountain. To the left you will see a short description of the different parts of the trip. Please answer by clicking on the horizontal graph on each question.

Data Quality and Missing Data

The data quality varied across participants and during the event. This is partly due to the fact that the recruited skiers represented a wide range of skill levels (resulting in faster or slower descents) and that the data were gathered on a range of different mountains (resulting in longer or shorter routes).

Factors influencing data-quality were frequency of falls, sun in the background (which made the automatic identification of facial expressions impossible), accidental changes in camera position (e.g., after a fall) or changes in face visibility (e.g., scarves that were adjusted and then occluded parts of the face).

Regarding the very different percentages of missing values, we have to specify exclusion criteria for each of the analyses separately. These are specified and discussed for each analysis as the available data pose restrictions in different ways for different analyses.

RESULTS

Descriptive Statistics

The mean ski trip duration was 32.49 min (ranging from 7.96 to 92.69 min with SD = 15.08). **Figure 2** shows histograms of the total duration (number of minutes, left panel) that our participants were skiing (top row) or not skiing (bottom row and labeled "other") and the percentage of missing data points (right column). The data quality varied across participants and over the event, resulting in a mean percentage of missing data of 44.50%, SD = 25.50). For descriptive statistics for self-reported emotions see **Table 1**.

Difficult Activities Are Not Pleasant

The first hypothesis predicts that participants are happier when they stop skiing, than when they are actively downhill skiing, and facially expressed happiness was used to test it. Only participants with at least three minutes of valid skiing data and another 3 min of data collected in the breaks were included in the test of our first hypothesis, providing a sample of $N = 33$ for this analysis. This sample consisted of 20 men and 13 women with an age range from 19 to 36 years ($M = 25.76$, $SD = 4.07$).

A linear mixed model with random intercepts and emotions (with neutral as the baseline) and activity type – ski or break (with skiing as the baseline) as regressors was conducted. The t-tests used the Satterthwaite approximation with $df = 2$.

A main effect for activity was found, with an unstandardized regression coefficient $B = 0.05$, $p = 0.043$ indicating that facially expressed emotions were more intense during skiing than during ski breaks. In addition, all five emotions showed significantly lower activation scores compared to the "Neutral" classification

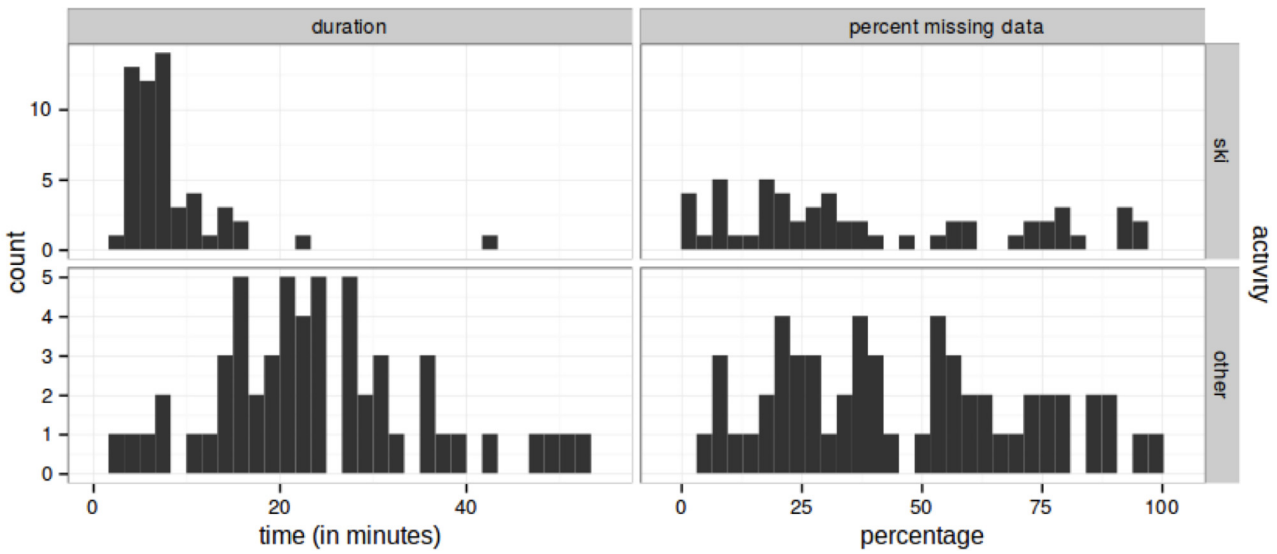

FIGURE 2 | Total duration (in minutes, left column) and missing data (in percent, right column) of skiing (top row) and ski-breaks (bottom row). Written informed consent has been obtained from the participant for the publication of this image.

TABLE 1 | Descriptive statistics with mean (M) standard deviation (SD) and standard error of mean (SEM) for self-reported episode emotions.

Variable	*M*	*SD*	*SEM*
Pleasure	5.34	1.80	0.83
Happiness	5.76	1.34	0.90
Satisfaction	5.63	1.55	0.88
Interest	5.12	1.38	0.80
Engagement	4.63	1.61	0.72
Enthusiasm	5.10	1.39	0.80
Fear	2.46	1.66	0.39
Anger	1.68	1.51	0.26
Sadness	1.34	1.24	0.21

N = 43.

(all *p*s < 001). More interestingly, happy feelings increased significantly during breaks (baseline), $B = 0.169$, $p < 0.001$, confirming Hypothesis 1. Please cf. **Figure 3** and **Table 2** for further details.

Moment-by-Moment Emotions and Recalled Event Emotions

In accordance with the FWA, the second hypothesis predicts that there will not be a strong relationship between the moment-by-moment emotions experienced during a difficult event and the emotions reported from the overall event.

To test this hypothesis we ran two series of independent linear regression analyses. In the first series, we used the total means of the seven facially expressed event emotions as independent variables in five separate regression models (one for each of the self-reported emotions). Only participants with at least three minutes of valid data from skiing and completed self-reported event scores were included in the first analyses, providing a sample of 46 participants (27 male, 19 female, age range 19–46, $M = 26.96$, $SD = 5.51$).

The results from these five analyses are reported in **Table 3**. As can be seen in the table, only few of the facially expressed event emotions predicted self-reported event emotions: Facially expressed sadness was inversely related to self-reported happiness ($\beta = -0.56$, $p = 0.020$) and facially expressed fear was related to self-reported interest ($\beta = 0.37$, $p = 0.041$). In addition, neutral expressions predicted self-reported anger ($\beta = 0.57$, $p = 0.022$) and sadness ($\beta = 0.69$, $p = 0.0027$).

In the second series of analyses, we divided the facially expressed emotions into skiing and breaks. Only participants with at least three minutes of valid data in each of the categories (skiing and breaks) and completed self-reported event scores were included, providing a sample of 31 participants (18 male, 13 female, age range 19–36, $M = 25.74$, $SD = 4.17$).

Neither of the facially expressed emotions for skiing nor the facially expressed emotions for breaks predicted self-reported event emotions. The results are summarized in **Table 4**.

Both series of analyses went against the predictions offered by the hedonic approach and in favor of the predictions of the FWA. These results are in line with the second hypothesis.

Gestalt Characteristics of the Moment-by-Moment Emotions at the Event Level

The third hypothesis predicts that self-reported event emotions can be predicted by certain gestalt characteristics of the moment-by-moment emotions, such as the emotions at the beginning or the end of the event. Facially expressed emotions were used as predictors to test the hypothesis. First, the data from the facially expressed emotion were divided into seven equal episodes, corresponding to the self-reported episodic emotions,

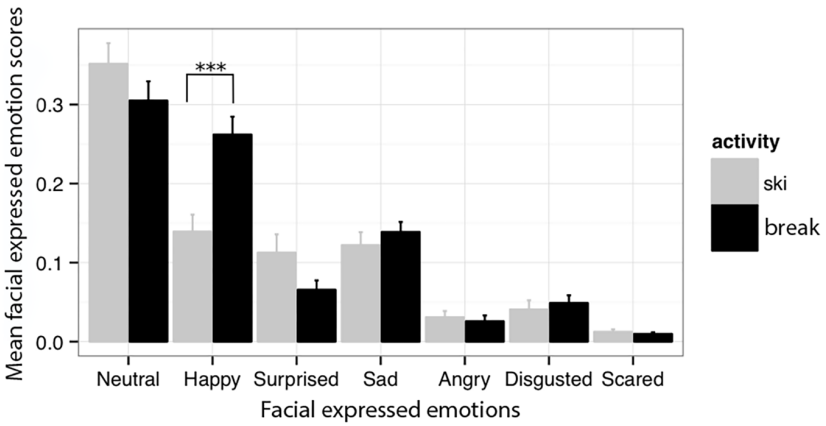

FIGURE 3 | Mean facial expressed emotions during skiing (gray) and breaks (black) across the six facial expressed emotions plus the generated neutral state. ***$p < 0.001$.

TABLE 2 | Summary of the random intercepts model for mean (M) and standard error of the mean (SEM) and goodness of fits indicators for facially expressed emotions during skiing and breaks.

	Dependent variable **Mean facially expressed emotion**	
	M	***SEM***
Happy	−0.21***	(0.02)
Surprised	−0.24***	(0.02)
Sad	−0.23***	(0.02)
Angry	−0.32***	(0.02)
Disgusted	−0.31***	(0.02)
Scared	−0.34***	(0.02)
ski-breaks × Happy	0.17***	(0.03)
ski-breaks × Surprised	−0.00	(0.03)
ski-breaks × Sad	0.06	(0.03)
ski-breaks × Angry	0.04	(0.03)
ski-breaks × Disgusted	0.06	(0.03)
ski-breaks × Scared	0.04	(0.03)
ski – breaks	−0.00	
Intercept	0.35***	(0.02)
Log Likelihood	402.245	
Akaike Inf. Crit.	−772.49	
Bayesian Inf. Crit.	−706.321	

***$p < 0.001$.

as displayed in **Figure 4** (cf. see section "Materials and Methods"), hereafter referred to as facially expressed episodic emotions.

Only participants with a minimum of 30 s of valid facial data in each of the seven episodes and with a complete record of self-reported event emotions were included, resulting in a sample of $N = 27$ participants (16 male, 11 female, age range 19–39, $M = 26.44$, $SD = 4.74$).

The results showed that none of the facially expressed emotions in any of these different episodes significantly predicted overall self-reported emotions. There were, in other words, no beginning or end effects, so Hypothesis 3 was not confirmed.

Moment-by-Moment and Recalled Emotions as Episodes

We also put forward two research questions, for which the presented theories gave no reason to deduce clear hypotheses. The first addresses the relation between the facially expressed episode emotions and the self-reported episode emotions.

We sat up three independent, random-intercept linear mixed models, with the same pre-conditions and sample as in the previous analysis. Each of the self-reported episode emotions (pleasure, interest and fear) was predicted by their corresponding facially expressed episode emotions. A new variable was generated to express the order of the episodes from 1 (the first episode) to 7 (the last episode). The new episode progress variable thus reflects the development of the three emotions during the entire trip.

To test whether the facially expressed episode emotions would add predictive power over and above what is to be expected from each of the episodes themselves, we compared the full model to a baseline model which had only episodes as a predictor (and random-intercepts). This comparison was not significant for self-reported pleasure and interest (pleasure: $\chi^2(7) = 10.8$, $p = 0.149$; interest: $\chi^2(7) = 4.88$, $p = 0.674$) but reached significance for self-reported fear, $\chi^2(7) = 18.51$, $p = 0.010$.

When investigating these models in more detail, however, we found that facially expressed episode sadness predicted self-reported episode fear, $\beta = 0.68$, $p = 0.001$ and facially expressed fear was inversely related to reported pleasure, $\beta = -2.37$, $p = 0.049$ (cf. **Table 5**).

Similarities and Differences Between Pleasure, Interest, and Fear at the Episode Level

Our second research question asks for possible similarities and differences between pleasure, interest, and fear across the 7 self-reported episodes that are nested in the entire event. Among the 38 participants who completed the self-reported episode emotions, six were excluded due to lack of variance

TABLE 3 | Standardized regression coefficients (β), standard errors (in parenthesis) and overall statistics for five models predicting self-reported event emotions by the means of the facially expressed emotions.

	Self-reported event emotions				
Mean facially expressed emotions	**Anger**	**Fear**	**Sadness**	**Happiness**	**Interest**
Neutral	0.57* (0.24)	0.36 (0.23)	0.69* (0.22)	−0.24 (0.24)	−0.06 (0.23)
Happy	0.21 (0.25)	0.01 (0.24)	0.11 (0.22)	−0.05 (0.25)	0.24 (0.24)
Surprised	0.01 (0.23)	−0.02 (0.22)	0.06 (0.20)	−0.37 (0.23)	−0.10 (0.22)
Sad	0.33 (0.23)	0.32 (0.22)	0.10 (0.21)	−0.57* (0.23)	−0.29 (0.22)
Angry	0.07 (0.18)	−0.13 (0.17)	−0.02 (0.16)	−0.05 (0.18)	−0.17 (0.18)
Disgusted	−0.03 (0.19)	−0.23 (0.18)	0.01 (0.17)	0.10 (0.19)	0.27 (0.18)
Scared	0.17 (0.18)	0.21 (0.18)	0.01 (0.16)	0.30 (0.18)	0.37* (0.18)
Intercept	0.00 (0.14)	0.00 (0.14)	−0.00 (0.13)	0.00 (0.14)	0.00 (0.14)
R^2	0.22	0.27	0.37	0.22	0.27
Adjusted R^2	0.08	0.14	0.26	0.08	0.13
Residual Std. Error (*df* = 38)	0.96	0.93	0.87	0.96	0.93
F Statistic (*df* = 7; 38)	1.56	2.03	3.24**	1.57	1.98
p-values	0.170	0.077	0.009	0.174	0.084

*$p < 0.05$; **$p < 0.01$, $N = 46$.

TABLE 4 | Standardized regression coefficients (β), standard errors (in parenthesis) and overall statistics for five models predicting self-reported event emotions by the means of the facially expressed emotions during breaks (upper part) and skiing (lower part).

	Overall self-reported emotions				
Facially expressed emotions	**Anger**	**Fear**	**Sadness**	**Happiness**	**Interest**
During break					
Neutral	−0.01 (0.76)	−0.61 (0.78)	0.19 (0.76)	−0.42 (0.70)	−0.67 (0.73)
Happy	−0.56 (0.67)	−0.73 (0.68)	0.11 (0.66)	−0.20 (0.61)	−0.22 (0.64)
Surprised	−0.48 (0.75)	−0.18 (0.76)	0.48 (0.74)	−0.44 (0.68)	0.30 (0.72)
Sad	−0.44 (0.51)	0.09 (0.51)	0.14 (0.50)	−0.85 (0.46)	−0.27 (0.49)
Angry	−0.33 (0.54)	−0.55 (0.54)	−0.06 (0.53)	0.46 (0.49)	0.21 (0.51)
Disgusted	0.74 (0.46)	−0.16 (0.46)	0.07 (0.45)	−0.07 (0.42)	−0.14 (0.44)
Scared	−0.28 (0.44)	−0.22 (0.45)	−0.20 (0.44)	0.24 (0.41)	−0.11 (0.43)
During ski					
Neutral	0.80 (0.71)	0.84 (0.72)	0.84 (0.71)	−0.11 (0.65)	0.49 (0.68)
Happy	0.84 (0.65)	0.71 (0.66)	0.27 (0.64)	−0.13 (0.59)	0.44 (0.62)
Surprised	0.44 (0.47)	−0.13 (0.48)	−0.01 (0.47)	−0.53 (0.43)	−0.71 (0.45)
Sad	0.67 (0.38)	0.05 (0.39)	0.29 (0.38)	0.02 (0.35)	−0.14 (0.36)
Angry	0.79 (0.58)	0.39 (0.59)	0.03 (0.58)	−0.46 (0.53)	−0.29 (0.56)
Disgusted	−0.83 (0.49)	−0.11 (0.50)	−0.01 (0.48)	0.24 (0.45)	0.34 (0.47)
Scared	0.61 (0.44)	0.51 (0.44)	−0.12 (0.43)	0.30 (0.40)	0.43 (0.42)
Intercept	−0.00 (0.19)	0.00 (0.19)	0.00 (0.18)	−0.00 (0.17)	−0.00 (0.18)
R^2	0.44	0.42	0.44	0.53	0.48
Adjusted R^2	−0.06	−0.09	−0.04	0.11	0.03
Residual Std. Error (*df* = 16)	1.03	1.04	1.02	0.94	0.99
F Statistic (*df* = 14; 16)	0.86	0.83	0.91	1.27	1.06
p-values	0.580	0.630	0.560	0.320*	0.450*

*$p < 0.05$, $N = 31$.

(for all episodes, four reported zero fear and two reported maximum pleasure). **Table 6** provides descriptive statistics for the variables.

The analysis described in the previous section included a "trend" analysis for pleasure, interest, and fear as the episodes unfolded from the start to the end of the entire event (the episode progress variable). Episode progress turned out to be a significant predictor for the self-reported episode emotions of interest ($\beta = -0.04$, $p < 0.001$) and fear ($\beta = -0.049$, $p < 0.001$), but not for pleasure ($\beta = 0.001$, $p = 0.93$). These results reflect the

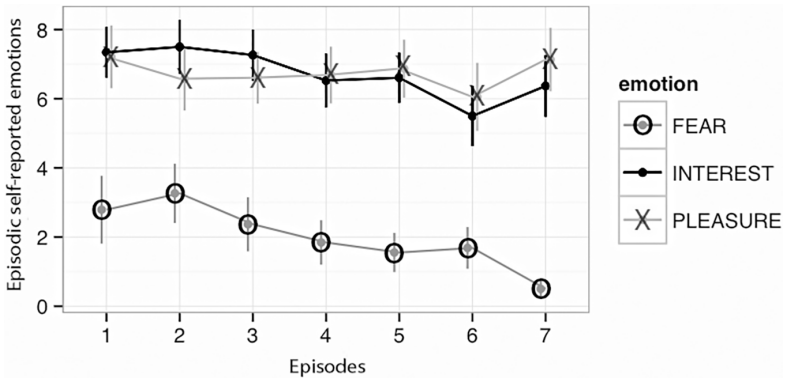

FIGURE 4 | Mean self-reported episodic fear, interest and pleasure for the seven episodes.

finding that interest and fear, but not pleasure, declined over the course of the event.

Finally, pairwise within-participant correlations between all pairs of self-reported emotions (fear – interest, fear – pleasure, and pleasure – interest) were calculated. These within-participant correlations were transformed using Fishers Z-transform (Fisher, 1915), averaged and back-transformed. We found that self-reported fear and interest were moderately correlated, $r = 0.47$, $t(31) = 3.43$, $p = 0.002$. In addition, fear and pleasure were negatively related, $r = -0.18$, $t(31) = -0.80$, $p = 0.43$ and pleasure and interest showed a stronger, positive correlation, $r = 0.52$, $t(31) = 3.06$, $p < 006$.

DISCUSSION

This paper tested a new method of measuring emotions during an extreme sport by capturing and analyzing facially expressed emotions as they unfold moment-by-moment during an intense, outdoor activity. The results show that the participants appeared happier when they had a break than when they were actively skiing. We also found the facially expressed emotions were poor predictors of the self-reported emotions collected immediately after the event. However, facially expressed fear predicted higher levels of self-reported interest, and facially expressed sadness predicted lower levels of self-reported pleasure. There were no apparent beginning or end-effects for facially expressed happiness as a predictor of self-reported happiness.

When the skiing event was separated into 7 successive episodes, the trends for self-reported interest and fear went from higher toward lower levels of intensity. No such decrease was observed for pleasure. Facially expressed fear also predicted lower levels of self-reported pleasure. The correlation between fear and pleasure across the 7 episodes was strongly negative, whereas it was positive between fear and interest. As expected, interest and pleasure correlated positively and significantly.

Our first finding shows that the participants expressed lower levels of happiness during skiing compared to when they stop to take a break. This pattern is consistent with the explanation offered by the flow theory (Csikszentmihalyi, 1999). The theory states that the enjoyment of flow is not consciously experienced, because people in flow are too involved in performing the activity at hand. There are no moment-by-moment experiences present during the flow event, the feelings appear only retrospectively, after the flow state has ended (Seligman, 2002).

Another explanation for our finding is offered by the Functional Wellbeing Approach. In contrast to the flow theory, the FWA suggests that people do have intense feelings during flow, but the experiences are not typically felt as joyful or happy. Rather, what people feel like during flow is interested, immersed and engaged, and these feelings are produced by the step-by-step execution of a challenging activity. The happiness reported afterward, however, is not supposed to be generated by an aggregation of the moment-to-moment feelings during flow, but by a different process altogether. The overall feeling of happiness

TABLE 5 | Standardized regression coefficients (β), standard errors (in parenthesis) and overall statistics for three models with self-reported episode emotions as dependent and facially expressed episode emotions as predictor variables.

	Self-reported episode emotions		
Facially expressed episode emotions	**Pleasure**	**Interest**	**Fear**
Happy	0.19 (0.20)	0.28 (0.19)	−0.00 (0.16)
Neutral	−0.20 (0.20)	0.23 (0.19)	0.16 (0.15)
Angry	−0.20 (0.55)	−0.10 (0.53)	−0.81 (0.42)
Disgusted	0.23 (0.32)	0.33 (0.31)	−0.22 (0.25)
Surprised	0.06 (0.21)	0.28 (0.20)	0.10 (0.16)
Scared	−0.37* (1.19)	−1.16 (1.14)	0.85 (0.93)
Sad	−0.19 (0.27)	0.20 (0.25)	0.68*** (0.20)
Episode progress	0.00 (0.01)	−0.04*** (0.01)	−0.05*** (0.01)
Intercept	0.75*** (0.13)	0.67*** (0.12)	0.27** (0.10)
Log likelihood	6.93	14.92	51.87
Akaike Inf. Crit.	8.13	−7.84	−81.75
Bayesian Inf. Crit.	43.79	27.82	−46.09

*$p<0.05$; **$p<0.01$; ***$p<0.001$. $N = 27$.

TABLE 6 | Descriptive statistics with mean (M) standard deviation (SD) and standard error of mean (SEM) for self-reported episodic emotions.

	Pleasure			Interest			Fear		
	M	*SD*	*SEM*	*M*	*SD*	*SEM*	*M*	*SD*	*SEM*
Episode 1	7.21	2.76	1.17	7.34	2.23	1.19	2.79	2.98	0.45
Episode 2	6.58	2.80	1.07	7.50	2.37	1.22	3.26	2.61	0.53
Episode 3	6.61	2.27	1.07	7.26	2.24	1.18	2.37	2.38	0.38
Episode 4	6.68	2.49	1.08	6.53	2.37	1.06	1.84	1.95	0.30
Episode 5	6.87	2.55	1.11	6.61	2.21	1.07	1.55	1.72	0.25
Episode 6	6.05	3.00	0.98	5.50	2.65	0.89	1.68	1.83	0.27
Episode 7	7.13	2.79	1.16	6.37	2.72	1.03	0.50	0.89	0.08

Scales for Self-Reported Episodic Emotions are 1–10. Episode refers to the different parts of skiing; (1) At the top, one minute before start, (2) the first part of the descent, (3) before half-way, (4) half-way down the mountain, (5) after half-way, (6) last part of the descent and (7) immediately after they stopped.

occurs as the result of having mastered a difficult task. It comes from a positive evaluation of a goal outcome.

The existing literature suggests that both skill development and positive emotions are important motives for extreme sport athletes. But extreme sport is not only positive emotions. Fear is for example the most dominant negative emotion in the present investigation, as it is in other studies (e.g., Brymer and Schweitzer, 2013). As one of the informants in Brymer and Schweitzer (2013) study pointed out, fear forces you to be alert and attentive to potential hazards. However, as Brown and Fraser (2009) argue, there has been a misconception in the literature about fear as a motive of its own for taking part in adventure sports activities. Several studies have described that the participants seek to overcome or master fear (Kerr and Houge Mackenzie, 2012; Langseth, 2015) or a necessary ingredient to produce thrill (Buckley, 2016). Fear is, in other words, not an emotion that the participants seek, but rather one they seek to overcome. They do so by reducing the level of challenge to fit within the frame of their capabilities. In addition to reducing fear, this also creates an arena for learning and development.

Flow theory and FWA disagree on how skills are developed. Flow is characterized by enjoyment and the theory postulates that a precondition for experiencing flow is a match between challenges and skill. The FWA, in contrast, postulates that there is a slight imbalance between experienced challenge and skills (tipping toward more challenging) which is ideal for skill development (Løvoll and Vittersø, 2014). Such an imbalance will lead to growth-oriented action guided by emotions like interest and engagement, not enjoyment. This view is supported by Schwartz and Wrzesniewski (2016) who argue that it is engagement and not pleasure that keeps people working toward difficult goals. Perhaps the most important point in FWA is that such situations, even though they are not pleasant, are still experienced as something worth pursuing for their own sake. Phenomenological they typically feel interesting, absorbing, or challenging.

The results from the self-reported episodes are consistent with the idea that happiness/pleasure and interest are distinct kinds of positive emotions. For instance, facially expressed fear predicted higher self-reported interest and lower self-reported pleasure. Self-reported interest was also positively correlated with fear and both interest and fear were experienced more intensely in the early phases and less intensely in the later phases of the descent. In contrast, self-reported pleasure was negatively correlated with fear and no difference in pleasure intensity was recorded during the event. However, since interest is not included in the FaceReader classification system, no facially expressed data are available to address the issue of how pleasure/happiness and interest might differ. We did not observed much facially expressed happiness during active skiing, though, which indicates that the pleasant kind of feelings are not the dominant experience for high arousal activities.

The FWA argues that whereas the moment-to-moment feelings are responses to the difficulty of ongoing activities, emotional feelings are created in response to an overall evaluation of the goal status for whole events. Moment-to-moment and emotional feelings are therefore responses to two different mental operations. The moment-to-moment feelings are communication about task difficulty while the emotional feelings are communication about goals and values.

In the current study, none of the facially expressed emotions captured during the activity predicted self-reported pleasure or interest. This may have several explanations. First, facially expressed interest is not yet established as a universal facial expression and thus FaceReader, the AFC tool used in this study, does not have the capability to read facially expressed interest.

In a recent article, Campos et al. (2012) found that interest is characterized by lowered eyebrows and raised inner eyebrows. In addition they found a weak correlation between interest and compressed lips and also raised outer eyebrows. Happiness shares none of these characteristics. However, facially expressed sadness is strikingly similar.

In a previous study on the emotional experience of extreme sport, Hetland and Vittersø (2012) found that the participants reported a total absence of sadness. The results in this study, however, show that facially expressed sadness is the second-most prominent emotion expressed during the activity, second only to happiness[1]. A similar result was also found in another recent study where tourists watched tourist commercial films (Hetland et al., 2015). Here the participants expressed more sadness and anger compared to happiness while they watched the films.

[1]Note that the neutral state generated by the AFC software is not seen as an emotion.

Afterward, however, they reported high levels of happiness and low levels of sadness.

The results from the current study also show that facially expressed sadness predicts self-reported fear. By itself, such a finding is difficult to explain; yet if we turn to the self-reported episode emotion findings, the results show that interest and fear are positively related. Pleasure and fear, on the other hand, correlate negatively. Seen together, these findings might suggest that facially expressed sadness in some situations can actually be mislabeled interest. Future studies are needed verify the distinct characteristics of facially expressed interest.

Another explanation for the lack of coherence between the self-reported and facially displayed emotions can be that the participants, in fact, are unable to recognize and report their own emotions. This difficulty is called alexithymia, and in a recent study Barlow and his colleges (Barlow et al., 2015) show that people with such difficulties seek extreme sport activities to experience more clear cut emotions. Indeed, Hetland and Vittersø (2012) have shown that the emotional landscape in BASE jumping and skydiving characterized by a few clear and strong emotions, like pleasure and fear – and total absence of others like sadness.

Limitations and Future Research

This study applied a design with automated facial coding of emotions during high intensity activities. Even though this method opens up new possibilities, it is not without shortcomings. First, this technology was initially developed to function in controlled settings such as a laboratory. Even though the software has become more robust in recent years, the shifting lighting conditions in the field are challenging. For this, and other external factors, a number of participants had to be excluded from the various analyses due to strict criteria for missing data. This led to a limited sample size entering our final analysis, so interpretation of our results should therefore be seen as tentative and as being the result of exploratory rather than a confirmatory nature. The effects found in the current study should therefore serve as an effect-size estimate to inform adequately powered follow-up studies investigating the same or related phenomena.

Also, in order to be able to correctly capture facially expressed emotions, the participants were instructed to ski without goggles. In addition, the camera had to be placed directly in the participants' field of vision. Although most participants said they quickly habituated to these conditions, these factors might have affected their display of facial expressions.

Moreover, the present study used video-input, and not still images, to analyze facial expressions. Theoretically, film is nothing more than still images displayed in rapid sequence, and FaceReader analyze each frame as a still image. The validity of FaceReaders ability to correctly analyze still images is well established. However, a validity study using video as input would be beneficial in order confirm this validity while using video as input.

In contrast to previous studies of emotional experiences of extreme sport, this study finds that facially expressed sadness is the most prominent moment-to-moment emotion after happiness. Recent studies show that there is a similarity between the facial expressions related to interest and sadness. A possible limitation of the present results is, therefore, that what has been coded as sadness might, in this type of experience, sometimes actually be mislabeled interest.

Relatedly, we lack sufficient knowledge for analyzing emotions that are not "basic" in the Ekman sense of the term. Currently, these are categorized as "Neutral" by the FaceReader, but this "grab-bag" category may have emotional content not captured by the FACS system. Finally, facial expression can, like most other reports of emotions be hidden (Gross and Feldman Barrett, 2011).

In spite of its shortcomings, the FaceReader technology gives us a first peek into how an intense activity like backcountry skiing is experienced as it unfolds – an opportunity that has been unavailable until now. And when it comes to detecting happiness—the major emotion for the present study—the FacerReader seems particularly well equipped.

CONCLUSION

The current article provides, to our knowledge, the first study of moment-by-moment emotions during an intense experience like backcountry skiing. It does so by introducing a new way of measuring moment-to-moment emotions in the field by use of small video cameras and software for coding facial expressions. The article argues that the Functional Wellbeing Approach (over the Hedonistic and Gestalt approaches) is best at predicting and understanding how moment-by moment experiences relate to retrospective evaluations. The results show that the skiers express less happiness while they ski, compared to when they stop to take a break. Further, there is no apparent relation between the facially expressed emotions and any of the positive self-reported emotions reported immediately after the trip.

In the end, we may be able to explain why extreme sport athletes report happiness to be their main motivation even though they don't feel much happiness as long as they are inside the pursuit of the activity. From a functional wellbeing approach, an event can be successfully mastered and thus be remembered as pleasant, even if the subtasks involved are experienced as challenging or even painful. Hence, it seems that memorable events do not develop their emotional meanings from of a series of moment-to-moment feelings—they are generated from something bigger. Much, perhaps, like the happiness of our lives in general.

ETHICS STATEMENT

In the spirit of the Declaration of Helsinki, all of the participants were given full information about the project and what their participation involved. The sample was drawn from a healthy adult population, and all participants signed an informed consent

before they were included in the study. The project was approved by the Norwegian Social Science Data Service (license number 32675). In addition institutional and APA ethical standards were followed throughout the work of this study. None of the authors have any conflicting interests.

AUTHOR CONTRIBUTIONS

AH is main author of this paper. JV and TD contributed substantially to developing the theory, design, and to writing the manuscript. SW and EK contributed to data collection, preparation for analysis, and writing the method section. MM conducted all statistical analysis and wrote the results section.

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An Ecological Conceptualization of Extreme Sports

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Currently, there are various definitions for extreme sports and researchers in the field have been unable to advance a consensus on what exactly constitutes an 'extreme' sport. Traditional theory-led explanations, such as edgeworks, sensation seeking and psychoanalysis, have led to inadequate conceptions. These frameworks have failed to capture the depth and nuances of experiences of individuals who refute the notions of risk-taking, adrenaline- and thrill-seeking or death-defiance. Instead, participants are reported to describe experiences as positive, deeply meaningful and life-enhancing. The constant evolution of emerging participation styles and philosophies, expressed within and across distinguishable extreme sport niches, or forms of life, and confusingly dissimilar definitions and explanations, indicate that, to better understand cognitions, perceptions and actions of extreme sport participants, a different level of analysis to traditional approaches needs to be emphasized. This paper develops the claim that a more effective definition, reflecting the phenomenology, and framework of an ecological dynamics rationale, can significantly advance the development of a more comprehensive and nuanced future direction for research and practice. Practical implications of such a rationale include study designs, representative experimental analyses and developments in coaching practices and pedagogical approaches in extreme sports. Our position statement suggests that extreme sports are more effectively defined as *emergent forms of action and adventure sports, consisting of an inimitable person-environment relationship with exquisite affordances for ultimate perception and movement experiences, leading to existential reflection and self-actualization as framed by the human form of life.*

Keywords: extreme sports, ecological dynamics, phenomenology, affordances, form of life, perception and action

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INTRODUCTION

Extreme versions of action and adventure sports, such as BASE jumping (including proximity flying), big wave surfing, rope-free solo climbing and big-mountain skiing or snowboarding, where death or severe injury is the most likely outcome of a mismanagement, mistake or accident, have been the subject of debate in various academic fields, e.g., psychology, sport science and outdoor studies.

In this perspective article, we propose a refined definition for 'extreme sports', specifically by looking at research on the most extreme versions of action and adventure sports, emphasizing a phenomenological approach. Preceding literature has explored extreme sports from a variety of frameworks and theoretical approaches, including sensation seeking (Rossi and Cereatti, 1993; Breivik, 1996), edgework (Laurendeau, 2006, 2008), type 'T' personality

(Self et al., 2006) and psychoanalysis (Hunt, 1996). These 'risk-centric' approaches have offered only narrow and superficial views on extreme sports, mainly based on assumptions that participation reflects an innate need for thrills, excitement or adrenaline-seeking, and in many cases characterizing participation as pathological and unhealthy.

In recent years, a growing body of literature has argued that these are over-simplified explanations (e.g., Allman et al., 2009; Kerr and Mackenzie, 2012; Brymer and Schweitzer, 2013a; Monasterio et al., 2014). Conversely, it has been proposed that participation helps develop a profound person-environment relationship that can potentially offer a variety of ways for enhancing psychological and physical well-being and health (e.g., Kerr and Mackenzie, 2012; Brymer and Schweitzer, 2017; Frühauf et al., 2017). Phenomenological research has recently provided valuable insights, contrary to previous explanatory frameworks. For example, many participants are reported to describe positive lived experiences, refuting the thrill-seeking and adrenaline notion, instead characterizing participation as deeply meaningful and life-enhancing (Brymer and Schweitzer, 2013a, 2017; Holmbom et al., 2017). (see **Table 1**) In summary, due to varying approaches and conceptual definitions in the literature, discourse has been rather confusing. Furthermore, researchers have been unable to advance a consensus on what exactly constitutes an 'extreme' sport.

In our earlier work, we proposed ecological dynamics as a holistic, comprehensive framework for defining sports performance and for the study of participation in action and adventure sports (Immonen et al., 2017). In this position statement, we seek to recognize that, while extreme sports often share seemingly similar foundations or emerge from a similar history with other forms of constantly evolving action and adventure sport disciplines, they have become distinct activities with their own participation characteristics. For example, while BASE shares characteristics with other parachute sports it also has distinct equipment, skills, psychological characteristics and so forth from other non-extreme cousins. Thus, in similar vein to our earlier work, we include many aspects from the definition of action and adventure sports, adopting the broad concept of *affordances* (Gibson, 1979/1986) framed by the notion of a 'form of life' (Rietveld and Kiverstein, 2014). We emphasize that, while extreme sports may share similarities with some participation styles of action and adventure sports, they are not to be understood as similar disciplines or forms of life. We further narrow the scope of the discussion and conceptual definition of the most 'extreme sports', guided by phenomenological findings and fundamentally defined as: *emergent forms of action and adventure sports, consisting of an inimitable person-environment relationship with exquisite affordances for ultimate perception and movement experiences, leading to existential reflection and self-actualization as framed by the human form of life.*

In the following sections, we explain how understanding of participation in extreme sports can be enhanced through *the ecological dynamics* framework and conceptual understanding as led by phenomenology. We argue that an ecological dynamics rationale is useful because it can help us understand the emergence of complex, dynamical individual-environment systems in an extreme sports context. This framework provides an appropriate holistic framework, adaptable to zoom in on multiple perspectives and different time scales and levels of the person-environment system. This multidisciplinary and multidimensional viewpoint is necessary to make sense of the interacting constraints in extreme sports.

ECOLOGICAL DYNAMICS ENHANCES UNDERSTANDING OF EXTREME SPORTS

Ecological dynamics has been influenced by ideas arising from complexity sciences, evolutionary biology, ecological psychology and non-linear dynamics (Davids et al., 2008, 2013a). It offers explanations for the rich patterns formed in complex adaptive systems with multiple components and levels, e.g., brain and behaviors of individuals or groups functioning at different timescales (Davids et al., 2008). A fundamental attribute in complex dynamical systems (such as a sport performer or community) is that they continuously adapt and change their organizational states in a non-linear fashion through harnessing system self-organization tendencies (Kelso, 1997; Davids et al., 2008). This is characterized by emerging coordination between system components or degrees of freedom and by synergetic relations between individuals and an environment (Bernstein, 1967; Renshaw et al., 2009; Chow et al., 2014). Importantly, coordination is understood as emerging in multiple dimensions, i.e., as motor coordination (coordinating limbs and body parts as

TABLE 1 | Potential benefits of extreme sport participation.

(1) Increased positive psychological outcomes such as resilience, self-efficacy and positive affect	Brymer and Gray, 2009; Mackenzie et al., 2011; Brymer and Schweitzer, 2013a
(2) Opportunities to fulfill basic psychological needs of autonomy, competence and relatedness	Clough et al., 2016
(3) Opportunities to overcome challenge	Kerr and Mackenzie, 2012; Frühauf et al., 2017
(4) Opportunities to experience intense emotions	Brymer and Schweitzer, 2013a
(5) Increased physical activity levels	Gerber et al., 2012; Clough et al., 2016
(6) Experiencing integration with nature, i.e., *eutierria* (Albrecht, 2012, p.253)	Brymer, 2009; Brymer and Gray, 2009; Brymer and Schweitzer, 2015; Frühauf et al., 2017
(7) Contribution to deep friendships	Wiersma, 2014; Frühauf et al., 2017
(8) Positive transformational experiences	Allman et al., 2009; Brymer and Schweitzer, 2017; Holmbom et al., 2017

degrees of freedom in relation to context) (Bernstein, 1967), but also at psychological, emotional and social levels.

Key ideas of ecological dynamics include the following: (a) behaviors are examined and understood at the individual-environment scale of analysis, (b) perception of information provides opportunities for action (i.e., affordances) and is the basis of how behaviors are regulated at an individual level, and (3), performance behaviors are self-organized over time under interacting constraints (Davids et al., 2008, 2013a; Hristovski et al., 2011; Seifert et al., 2017). In this view, the individual is seen as a component amongst an array of influential constraints within an individual-environment system (Chow et al., 2011). To understand behaviors or experiences of individuals, we need to expand the scope from emphasizing the innate needs or personality traits of individuals as explaining behavior or performances and, instead, understand their multi-dimensional relations with performance environments as inherent parts of the system.

Constraints Shaping the Coordination of Behaviors

Constraints are boundaries or features shaping the emergence of each individual's cognitions, actions and decision-making processes (Newell, 1986). Three categories of key constraints include *individual constraints*, which can be structural (e.g., height, weight, body shape, technical abilities, connectivity of synapses in the brain), historical (e.g., development to tolerate lack of comfort) and functional (e.g., motivations, emotions, cognitions, perceptions) characteristics of an individual (Davids et al., 2008, 2013a). In many traditional sports, such as football or cricket, influential *task constraints* are formed by specific rules, task goals and instructional features (Cordovil et al., 2009; Orth et al., 2014; Greenwood et al., 2016). This is a fundamental difference in comparison to most extreme sports, since they are most often free of organizational frameworks, regulated competitive structures and thus, rule-bound *task constraints* (Davids et al., 2013b; Immonen et al., 2017). *Environmental constraints* can be physical (e.g., weather, ambient light, temperature or gravity), or sociocultural (e.g., values, family or peer support, cultural norms) (Davids et al., 2008, 2013b). Adding to complexity, extreme sports take place in different kinds of environments, for example on land, in the air or on water (afloat or submerged) (Breivik, 2010; Davids et al., 2013b; Immonen et al., 2017). For participants, it is crucial to become attuned to information in the environment by aligning coordination with natural conditions and sources of energy for action, such as the characteristics (tube, flat, etc.), size and speed of waves, currents and wind direction in big wave surfing. This is highlighted by the notion, that in any sport, but especially in extreme sports, constraints never remain truly fixed from one performance or session to the next (Rosalie and Müller, 2012). (**Figure 1**).

Affordances Embedded in a Form of Life

James Gibson's (1979/1986) concept of *affordances* has been widely discussed and debated in recent years, (e.g., Rietveld and Kiverstein, 2014; Rietveld et al., 2016; van Dijk and Rietveld, 2017; Withagen et al., 2017; Jordan et al., 2017). The widespread consensus contains the idea that affordances are relational 'concepts' combining features of the environment with individual *effectivities,* perceived on the basis of what they offer, invite or demand for an individual in terms of action possibilities. For instance, different surfaces, substances, objects or other individuals in the environment can afford different possibilities for different people in relation to individual constraints. *Effectivities* are complementary capabilities of an individual that can realize affordances in coherent forms of behavior (Shaw et al., 1982; Davids et al., 2016). Thus, the same mountain face or cliff can be seen as an affordance to play on a vertical plane for some climbers, to get airborne for BASE jumpers, or as a hazardous feature to avoid for recreational hikers. Also, in contrast to a novice, a skilled climber might perceive different kinds of opportunities (i.e., routes or moves) complementary to individual physical or psychological capacities due to learning and experience.

The Wittgensteinian concept of *'form of life"* (Rietveld and Kiverstein, 2014) implies how sociocultural practices of humans can constrain the emergence of specific behavioral patterns. It is a key concept emphasizing that *effectivities* are not merely relative to particular individuals actually perceiving or detecting affordances, but also have an existence relative to the skills available in practice (an ecological niche), or, to the abilities available in a form of life as a whole. There cannot be a distinguishing discipline without the skills (relatively stable, collectively aligned perception-action couplings) defining it and enabling more affordances to be 'revealed' within, or further, beyond the sociocultural context (Immonen et al., 2017). Ingold (2000/2011) argues that much of what is called 'cultural variation' is in fact the variations of skills. To provide a practical example of skills relative to a specific (extreme vs. non-extreme) niche: a big mountain skier needs a mix of expert skiing skills and mountaineering skills. In addition, (at an extreme level) a deep knowledge of her/his personal constraints as well as constraints of the task and the environment are necessary, when adapting to a changing mountain terrain, weather and snow conditions or unpredictable social environments. In contrast, an urban freeskier might need a wide set of acrobatic manoeuvers and skills to shape the environment (e.g., building features from snow) to facilitate emergence of specific (aesthetic or original) styles of performance.

It might be useful and even necessary to acknowledge historical transformation patterns and influences, by including concepts such as *subcultures* or *lifestyles* (as types of constraints within a wider societal context) that can significantly shape participation of individuals. These notions alone, however, prove to be insufficient for the deeper examination of experiences, skill acquisition or evolution of niches. An essential notion here is that, although needed for 'effective' performance, high embodied skill level and expert knowledge (about self, task and performance environment) might not necessary lead to participation at extreme levels. Therefore, "An ecological niche is something that is available to a population of organisms, even if it is not completely used by any one member

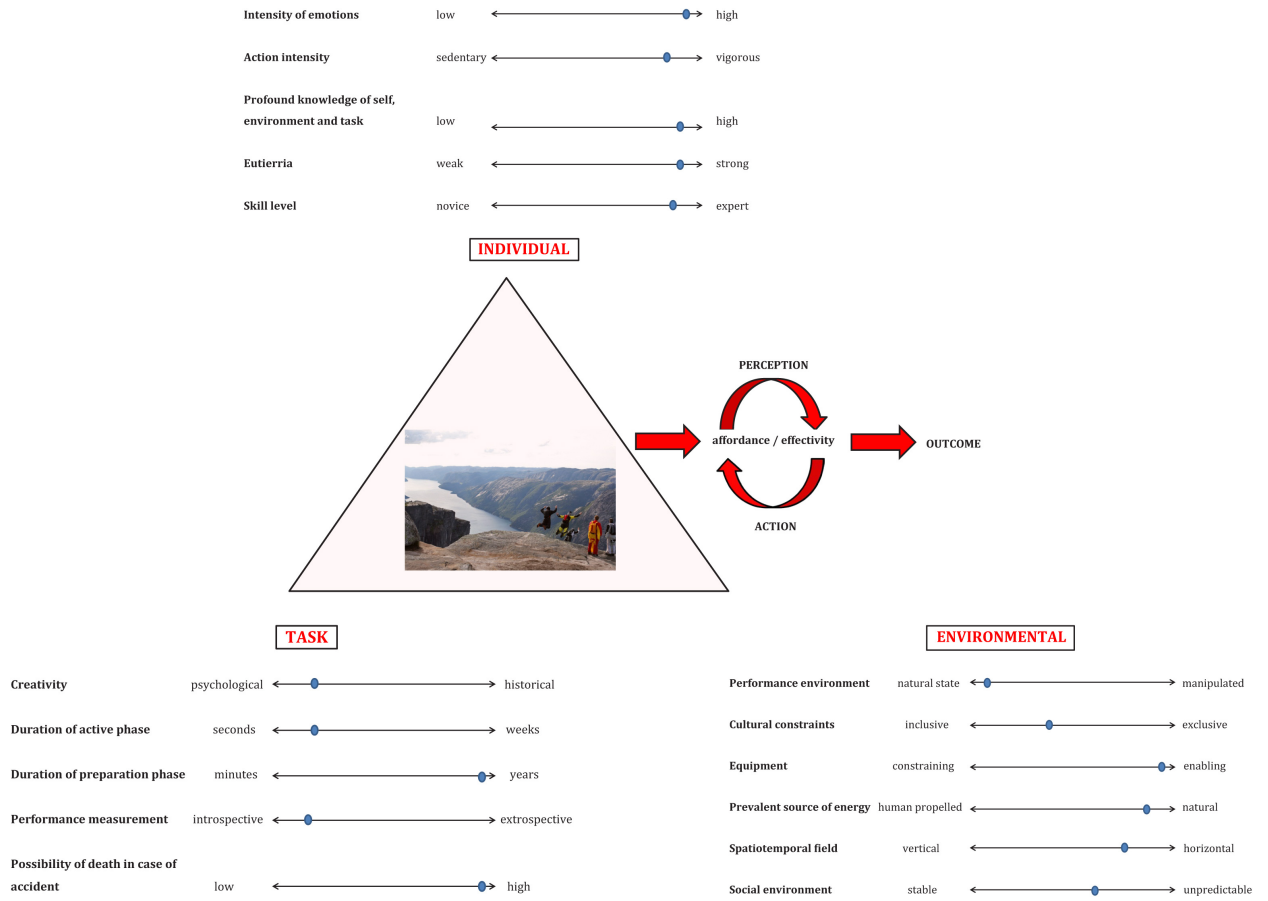

FIGURE 1 | Derived from ideas of Newell (1986), Davids et al. (2008) and Immonen et al. (2017). Emerging, adaptive performer-environment relationships are scaled by situational and context-dependent key constraints that, in combination, define an extreme sport form of life/participation style. The comprehensive lens of Ecological dynamics is illustrated due to its capability to zoom into participation and engagement on multiple levels of analysis and time frames, reflecting extreme sport niches and performance outcomes as influenced and shaped by constraints from variety of levels. Due to the infinite combinations and complexity of interactions, irregular and unpredictable constraints are illustrated on continua, attending to significant situational and contextual fluctuations in each participant's experience. To exemplify, exact positions on each continuum are depicted to illustrate the significance of each situational influencing constraint, which together as a whole consist the exemplary experience of a particular BASE jumper. For better understanding, new emerging constraints should be *a posteriori* included in the model according to complementary research findings and constant evolution of extreme sports. Included in the figure are constraints illustrating varying characteristics and performance environments of extreme sports in their current states of development and as reported in existing literature (e.g., Boden, 1996; Brymer and Oades, 2008; Brymer, 2009, 2010; Brymer and Gray, 2009; Thorpe, 2009; Breivik, 2011; Hristovski et al., 2011; Langseth, 2011; Varley, 2011; Albrecht, 2012; Kerr and Mackenzie, 2012, 2014; Davids et al., 2013b, 2016; Brymer and Schweitzer, 2013b, 2017; Wiersma, 2014; Yeh et al., 2015; Clough et al., 2016; Frühauf et al., 2017; Holmbom et al., 2017; Seifert et al., 2017). It is notable, that high embodied skill levels might not necessarily facilitate participation in extreme sports. Although attunement to affordances enabling behavior on the edges of one's potential can be seen as a defining feature of the "extreme sport niche", behaviors of individuals are subtly interconnected by multitude of interacting constraints. Image source: https://www.google.fi/search?as_st=y&tbm=isch&hl=fi&as_q=base+jumping&as_epq=&as_oq=&as_eq=&cr=&as_sitesearch=&safe=images&tbs=sur:f#imgrc=xfiYZa1hXCqt1M:

of that population" (Reed, 1996). It is useful to understand affordances and effectivities at the defining level of a form of life (i.e., the extreme sport niche), but acknowledge the level of individual engagement with regard to emerging experiences and performance outcomes.

Importantly, defining feature within extreme sport context is that one can also come to realize (under certain constraints) the potential to explore beyond a particular form of life, or sociocultural boundaries (Holmbom et al., 2017; Immonen et al., 2017). The relative lack of rule-bound constraints emphasizes an essential characteristic as indicated by historical development patterns of many extreme sports; the desire for 'search'. This challenge is not limited only to search for functional solutions for motor problems (task) or exploration of new environments such as new mountain ranges, routes and climbing styles in mountain sports or greater depths in submerged sports. It also includes the exploration of personal capacities and profound (individual or shared) experiences or perceptions while the action unfolds (Davids et al., 2013b; Orth et al., 2017). Therefore, a distinguishing characteristic of extreme sports is that particular

features can invite participants to function, while coordinating actions by challenging norms or 'established' movement patterns (Immonen et al., 2017).

Evolution of Extreme Sport Niches Emerge Through Creative Exploration Under Interacting Constraints

Through closer examination, evolving extreme sport niches and individual performance outcomes are more complex than merely being subordinate to social norms or personality drives. They clearly involve individual tendencies to imagine, innovate and explore psychological capacities and possibilities outside of (affordances available to) a particular niche (Immonen et al., 2017). Psychological effectivities can thus support interactions of technical advancements and simultaneous exploitation of multiple affordances on many levels by an extreme sport athlete and lead to a new realization of the potential of human performance. Ingold's (2000/2011) outlook on understanding embodied skills of practitioners as attributes of cultural variation introduces three fruitful levels of analysis to the notion of form of life. This is exemplified by the evolution of niches with a basis in the use of parachutes within a similar performance environment or spatiotemporal field: (1) Human forms of life in general, due to phylogenetic and ontogenetic development, do not possess the skill of flying (e.g., compared to birds or airborne insects); (2) There exist specific and distinguishing sociocultural practices, i.e., regularities in the skilled performances, behaviors and experiences of BASE-jumpers (extreme) as contrasted to sky divers (non-extreme) and (3) A more detailed, individual level of analysis indicates that skilled engagement with affordances is diverse, individualized and multi-dimensional within a specific sociocultural frame of reference. For instance, pioneers of proximity flying developed innovating wingsuits and airfoils to expand their body's surface area. This allowed exploration and the opportunity to perceive the spatiotemporal field in a new way through different kind of forward motion, i.e., the 'horizontal glide' (Berry et al., 2010; Mei-Dan et al., 2013). This evolution (from 'established' styles of BASE-jumping toward proximity flying) illustrates the intertwined nature of constraints. That is, individuals' experiences and performance outcomes emerge through interaction of underlying constraints on multiple levels. Simultaneously, the complex and non-linear evolution on all levels of the system (i.e., niches or disciplines) is inherently and bi-directionally dependent on the creative and exploratory behaviors of individuals.

Orth et al. (2017) proposed that, instead of a common proposition in cognitive science, where creative movement behaviors follow (or are an expression of) ideation (ideas represented in dedicated cognitive pathways), creative actions rather emerge while the action unfolds as a result of interactions amongst constraints. Importantly, creative actions are not, therefore, only products of individual constraints, but just as much emerge from interactions with task and environmental constraints. According to the ecological dynamics approach, this exploration is continuous and emerges over different timescales; not only when an action is produced, but also during practice and within and between practice sessions (Newell et al., 2001; Rosengren et al., 2003; Orth et al., 2017). Within complex adaptive systems, a state of *meta-stability* depicts when a system is poised between states of order and instability (Kelso, 2008). In the meta-stable state, fertile interactions can emerge spontaneously when previously uncorrelated system processes or components suddenly become interconnected under constraints (Chow et al., 2011). This is well illustrated by 'the strapped crew'. The group of Hawaiian surfers explored action possibilities outside of the affordance landscape of traditional surfing. They experimented how to match the speed and size of big waves with the assistance of a jet-ski by combining their experiences and knowledge about different kinds of equipment as surfers, windsurfers and snowboarders. This emerging style of surfing became known as tow-in surfing, which continually set new big-wave records as new waves previously considered too big and fast to catch by paddling became possible to be surfed on smaller boards with bindings and a surfing style previously unseen (Warshaw, 2010). This advance in extreme sports exemplifies how a particular, 'extreme' style of surfing was not born solely in the minds of individuals. On the contrary, it emerged as a result of interaction of evolving constraints and participants' exposure to landscapes of affordances on multiple domains. Through this expanded sociocultural frame of reference, broader landscape of affordances became available to be exploited during that particular era by individuals with adequate behavioral repertoire (Orth et al., 2018).

Through participating in various extreme sports or other non-extreme participation styles within action and adventure sports, which cross over, for example, in terms of equipment, environments or technical requirements, individuals are exposed to perceive multiple specific fields of affordances. Without this participation experience, more traditional exposure to sports may result in individuals inhabiting a narrow field in the affordance landscape. Additionally, technological advancements (e.g., affordance generation via social media) are constantly adding to the complex puzzle of psychological and social constraints that influence emerging individual-environment relationships. Thus, extreme sport niches in their current states of development should be seen only as 'temporal emergent products' of development in each area of individual, task and environmental constraints, yet open to constant evolution through creative exploratory behaviors. Therefore, it would be, at best, incomprehensive to define extreme sports without considering emerging creativity (meta-stability of the person-environment system) as an essential element.

NEW DEFINITION FOR EXTREME SPORTS AS GUIDED BY PHENOMENOLOGY

Human beings, as individuals within a form of life, engage the world in different ways. To understand the complex relationships of affordances and individual-environment systems, phenomenology is essential (Withagen et al., 2017). Phenomenology considers human consciousness as intentional,

which means that consciousness and cognition is always directed at something (Brymer and Schweitzer, 2017). *Intentionality* implies that parts can only be understood against the background of wholes and objects against the background of their horizons. That is, the experiences or perceptions of extreme sport participants cannot be comprehensively explored and understood without the notion of the underlying and intertwined constraints i.e., the context. Phenomenology focuses on the explanations of experiences as lived, beyond cultural or psychological boundaries (Brymer and Schweitzer, 2017). The *lifeworld* is another core doctrine of phenomenology (Husserl, 1970; Crease, 2012; Husserl, 2012). Humans 'seek' authenticity, companionship, happiness or pleasure amongst numerous other things and they do this in a variety of ways, e.g., as children, parents, teachers or, athletes. This illustrates different ways of being, i.e., modifications of an array of the practical connections human beings have to the world. This array is defined as the *lifeworld.* Importantly, the way of experiencing the world depends not only what one's environment in fact materially consists of, but also what is salient to an individual (Crease, 2012). As discussed earlier, this salience depends on relational properties (affordances) within a form of life. It again emphasizes the need to expand the scope of examination on extreme sports from strictly individual characteristics toward lifeworlds as individual compositions of the broader person-environment system.

Since many conceptual definitions influenced by traditional theory-led perspectives (e.g., Rossi and Cereatti, 1993; Self et al., 2006; Laurendeau, 2008) have led to interpreting extreme sport participation as pathological, socially unacceptable or unhealthy, the paradigm shift from risk-centric approaches toward more nuanced and comprehensive understanding of extreme sports has been mainly initiated by insights from phenomenological exploration of participants' experiences (e.g., Willig, 2008; Breivik, 2011; Brymer and Schweitzer, 2017). Findings from phenomenological exploration of participants' lifeworlds have shown that the extreme sport experience has the potential to dramatically change ways of being-in-the-world (Heidegger, 1996). For example, the profound person-environment relationship developed in extreme sports participation, can act as a facilitator to a deep, positive understanding of self and its place in relation to the environment (Brymer and Gray, 2009) i.e., *eutierria* (Albrecht, 2012). Experiencing intense fear can be a potentially meaningful and constructive event in the lives of participants, having implications for understanding fear as a potentially developmental and transformative process (Brymer and Schweitzer, 2013a). Participation can be a form of exploration of the ways in which humans experience fundamental human values (Brymer and Schweitzer, 2013b). Heidegger (1996) thought that a core aspect of being a human is our capability to make new worlds. Through the notion of form of life, extreme sports can be seen as a 'world' in similar fashion to the worlds of architecture or music, offering multiplicity of ways of being-in-the-world. This notion expands the perspective to broadly understand and define extreme sports, not solely as a pastime or 'sports' in a traditional sense, but as a type of form of life specific to being human. That is, as ways for humans to engage with the environing world and as mediums to explore physical or psychological capacities and, ultimately, what it means to be a human. Therefore, rather than a causal property of innate need, personality trait or any other single entity or component within the person-environment system, the extreme sport experience can be seen as a pure embodiment of the context, i.e., the composition of interacting, omnipresent and intertwined constraints (Jordan et al., 2017).

FUTURE QUESTIONS

Previous research has shown the evident link between affect, emotions and decision making (e.g., Blanchette and Richards, 2010; Angie et al., 2011). Studies have also indicated that in extreme sports, psychological factors such as fear, anxiety, excitement and pleasure, as well as beliefs and motivations, have significant roles during participation and a strong influence on how the environment is perceived by individuals (e.g., Sanchez et al., 2010; Lawrence et al., 2014). To better understand the relationship of decision making, affective constraints and 'invitational character' or 'affective salience' of affordances, more research is needed on the social dynamical systems within the extreme sport context. For example, research has indicated that as individuals, humans are prone to biased decision making (Kahneman, 2011) or 'heuristic traps' leading to accidents (McCammon, 2004), the complexity is further increased, and not well understood in research, when decision making emerges in group setting (Zweifel and Haegeli, 2014) in complex natural environments. Albeit the active phase of performance (Brymer and Schweitzer, 2017) is often executed alone, participants interact as parts of communities or groups during practice, preparation, planning or in terms of back-up safety. This addresses the need to better understand the metacognitive capacities, social systems and decision making in extreme sports in order to develop effective practical implications such as affective learning designs (e.g., Headrick et al., 2015).

To avoid biases, such as fundamental attribution error (Ross, 1977), or falling into a trap of creating superficial observational lenses and definitions on extreme sports through reductionist paradigm or inadequate theoretical approaches, it is evident and crucial to form a descriptive consensus on defining characteristics of extreme sports. Ideally, a definition should be free of negative connotations or pre-assumptions and approved by researchers and practitioners. The definition proposed in this paper builds upon a conception of 'action and adventure sports' (Immonen et al., 2017) and defining characteristics of the extreme sport experience as indicated by the phenomenological research. Here, we argue, that what makes the difference between extreme and non-extreme sport, is the particular type of emerging experience and the ensuing changes in ways of being-in-the-world (Heidegger, 1996). This occurs when specific performances, often by facing danger or potential death, make deep existential structures visible and available to be experienced, and which is unavailable to be reached within traditional sports or non-extreme participation styles within action and adventure sports. When adopting the definition, it

is worth emphasizing that researchers need to fully understand the interacting constraints of the sport in question, and carefully consider how study designs, research questions, experimental tasks or interventions maintain the coupled dynamical processes of perception and action against the situational and contextual horizon (Brunswik, 1956; Pinder et al., 2011).

CONCLUDING REMARKS

We have argued that an ecological dynamics framework is well-suited for the study of extreme sports due to the multi-dimensional scale of analysis combined with the encompassing and descriptive definition of extreme sport as guided by recent phenomenological research. This perspective provides a holistic lens to scrutinize extreme sports as *forms of life* specific to humans, which are clearly distinguished from traditional sports or non-extreme participation styles of action and adventure sports. In addition, the notion of form of life and different levels of analysis allow us to explore extreme sports through specific features across niches or disciplines as sociocultural frames of reference (e.g., freediving as contrasted to free solo climbing) and at a more detailed individual level (i.e., experiences or learning). Thus, for a nuanced and comprehensive understanding of extreme sports, we propose that experiences and performance outcomes of individuals should be considered as embodiments of complex and dynamic, interacting individual-environment systems emerging through the composition of situational and contextual constraints.

We have emphasized that the creative exploratory behaviors of participants form a crucial and defining characteristic. This continuous 'search' for the meta-stable regions of the system, where ineffable experiences and creative performance outcomes emerge, is an essential merit for an activity which, in our view, can be called 'extreme sport'. So far, it has been the phenomenological exploration, which has offered the most valuable insights on individuals' experiences. Therefore, by understanding extreme sports as distinguished, emerging and constantly evolving niches and adopting the definition based on previous phenomenological research findings and theoretical principles of ecological dynamics, we propose extreme sports to be defined as: *emergent forms of action and adventure sports, consisting of an inimitable person-environment relationship with exquisite affordances for ultimate perception and movement experiences, leading to existential reflection and self-actualization as framed by the human form of life.*

AUTHOR CONTRIBUTIONS

TI, EB, KD, JL, and TJ contributed to the conceptualization, drafting the work, and background research.

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To Analyze Thrill, Define Extreme Sports

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Emotions are a signaling system, evolved by providing selective advantage through enhanced survival and reproduction. The selective advantage conferred by thrill or exhilaration, however, remains unknown. Hypotheses, as yet untested, include overcoming phobias or honing physical skills as juveniles, or exhibiting desirability during mate selection. Extreme sports can provide an ethically and experimentally feasible tool to analyze thrill. To use this tool, extreme sports must first be defined in a non-circular way, independent of participant psychology. Existing concepts, from different disciplines, focus, respectively, on drama, activity types, or consequences of error. Here, I draw upon academic and popular literature, and autoethnographic experience, to distinguish extreme from adventurous levels for a range of different outdoor sports. I conclude that extreme outdoor adventure sports can be defined objectively as those activities, conditions, and levels, where participant survival relies on moment-by-moment skill, and any error is likely to prove fatal. This allows us to examine the motivations, experiences, and transformations of individuals who undertake these activities. In particular, it will allow us to examine the emotional experience of thrill, previously studied principally as an aspect of personality, from new neurophysiological and evolutionary perspectives.

Keywords: adventure, outdoor, recreation, tourism, emotion, evolution, exhilaration

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INTRODUCTION

Why does thrill exist? Extreme sports can provide an analytical tool to answer that question. To use that tool, however, we must first define extreme, in an outdoor sporting context. Here, I examine that context, and use it to identify a definition that is theoretically coherent, avoids circularity, and can be implemented in practice. I propose this definition as a basis for future analysis of thrill, using participants in extreme sports as experimental subjects.

Human emotions can be studied from many different perspectives. For example, there is extensive research on: recognition and classification (Johnson-Laird and Oatley, 1989; Oatley et al., 2006); behavioral antecedents and outcomes, differences related to individual personalities, and social roles and functions (Turner and Stets, 2006; Niedenthal and Brauer, 2012); biochemistry, physiology, and neurology (Mujica-Parodi et al., 2014; Orsini et al., 2015; McAllister and Nichols, 2018); and in some cases, selective advantages and evolutionary origins (Tooby and Cosmides, 1990; Nesse and Ellsworth, 2009; Sandseter and Kennair, 2011; LeDoux, 2012; Verma et al., 2016; Pacella et al., 2017).

As with any aspect of human bodies and brains, emotions have evolved through past constraints and pressures, creating comparative selective advantages for individuals with particular traits. We have physical bodies with functions and actions, monitored and controlled by senses, brains, nerves and hormones. But we also have the self-perceived psychological sensations known as

emotions, which act as integrated signals of interactions between ourselves as individuals, and our environments, including other people. "Emotions control evolutionarily conserved behavior that is central to survival in a natural environment" (Verma et al., 2016).

What specific selective advantages do we gain from each individual emotion? For some emotions, it is not difficult to propose plausible possibilities. Fear, for example, can be a rapid and powerful signal of immediate threat, requiring a so-called fight or flight response (Do Monte et al., 2016). Anxiety signals a computation that there is an above average probability of an unfavorable outcome. One type of love seems to be a signal of an otherwise undetectable immunochemical aspect of genetically optimal mate selection. Disgust, e.g., at a rotting carcass, may represent an integrated signal, based on smell and sight, of substances likely to cause illness or infection. All of these signals could well provide selective advantages. Emotions, however, are indefinitely nuanced and complex. For some emotions, the evolutionary functions are far from clear. Thrill is one such emotion.

CONTEXT

Why Does Thrill Exist?

How did thrill, exhilaration, and associated emotional responses evolve? What advantage does an individual human gain from the emotion of thrill, that could improve their chances of producing successful offspring, e.g., through extended survival or advantageous mate selection? Thrill has been studied principally in relation to so-called thrill-seeking or sensation-seeking personalities (Self et al., 2006; Zuckerman, 2007; Woodman et al., 2010; Kruschwitz et al., 2012; Monasterio et al., 2016; Baretta et al., 2017; Zheng et al., 2017); and as a driver of behavioral patterns considered dangerous, abnormal, criminal, or addictive (Lyng, 1990; Elmes and Barry, 1999; Franques et al., 2003; Buckley, 2015a). Thrill, however, is part of the normal panoply of human emotions. It can be experienced by anyone. It is used as a component of education (Berman and Davis-Berman, 2013) and therapy (Gass et al., 2012). It is a commonplace component of commercial tourism products and experiences (Gibson, 1996; Buckley, 2012; Pomfret and Bramwell, 2016; Holm et al., 2017; Lee et al., 2017; Smits, 2018).

As yet, however, there is apparently no accepted model for the evolutionary role or selective advantages conferred by thrill. There seem to be only two published hypotheses to date, neither yet tested. Sandseter and Kennair (2011) suggested that thrill might provide a mechanism for children to overcome phobias. Buckley (2016) suggested that the emotion of thrill might lead juvenile individuals to test and practice their skills, honing them for use later, when they could be needed suddenly for survival. If this is indeed the case, then thrill could play the same role for many animal species, not only humans. There is longstanding evidence for play amongst many species, including mock fights in mammals, and aerobatic maneuvers in birds (Lorenz, 1949/1961); but with little evidence regarding their psychological states. Likewise, if thrill evolved so as to hone skills, then we would anticipate that thrill would lose its attractiveness for adults, whose skills are already developed. We should expect that adults would become increasingly risk-averse once they have invested substantially in resources for survival, competition for a mate, and parental care of offspring. This is indeed broadly the case. Some adult individuals, however, continue to seek lifelong thrills, though some other adults consider such behavior childish or irresponsible. A third possible hypothesis, apparently not put forward previously, is that thrill may lead individuals to display capability in risky activities, demonstrating skill as an aid in mate selection processes. This, however, seems less likely, since thrill does not depend on observers.

To analyze the emotion of thrill, we need individuals who experience it, preferably under experimentally controllable circumstances. Thrill has been reported in a wide variety of circumstances (Avanzi et al., 2008; Buckley, 2016). It is not clear, however, whether this breadth shows that thrill is a widespread and undifferentiated emotion, or alternatively, whether there may be many different kinds or variants of thrill, corresponding to different circumstances. That is, there is as yet no taxonomy of thrills. One of the core or archetypal circumstances or categories of thrill, however, is that experienced by participants in adventurous outdoor sports, including those described as extreme. Therefore, outdoor adventure and extreme sports can provide a laboratory for the study of thrill.

The intensity of thrill experienced by participants in outdoor adventure sports, and its relation to fear, varies considerably between individuals and circumstances (Buckley, 2016). The most intense emotion of thrill is likely to be associated with the more extreme sports. There is a risk of circularity, however, if we use extreme sports to study powerful emotions, but define extreme sports with reference to the strength of emotions experienced by participants. Therefore, to use extreme sports as a tool to analyze thrill, we first need to define extreme sports through external physical criteria unrelated to participant psychology. We can then examine the psychological characteristics and experiences of extreme sports participants without risk of circularity.

Significance of Defining Criteria

My aim here, therefore, is to consider whether there are recognizable, reliable, and repeatable criteria by which an independent observer can determine whether a specific outdoor adventure activity does or does not qualify as extreme; or alternatively, whether each individual participant sets their own criteria and definitions. That is, I consider whether extremeness can be defined as a characteristic of the setting and activity, rather than the participants' skills and mindsets.

This is a significant distinction, since the psychology of thrill during high-risk outdoor sports has a number of practical and theoretical implications. First, risk acceptance or aversion differs between individuals, and this applies to a wide range of different risks, including social, emotional, psychological, and financial risks, as well as immediate physical risks. Outdoor adventure provides a tool to analyze the psychology of risk aversion. Can we extend this analysis to extreme adventure? Second, the evaluation of physical risk and reward has been a critical component of

human history. It still is, for people who live in areas subject to war or terrorism, high crime rates, difficult terrain, or severe weather; and also for individuals in trades and professions such as the military, fire-fighting, emergency services, construction, tree lopping, electrical maintenance, and more. Outdoor adventure provides insights into human psychology and behavior, both individual and social, in high-risk situations; and these insights are relevant to management and safety in those professions. Can more extreme adventure provide more critical insights?

Third, outdoor adventure generates individual rewards, through immediate thrill or rush (Buckley, 2012) and longer-term self-esteem, personal transformation, and social recognition (Brymer, 2005, unpublished; Brymer and Oades, 2009; Brymer and Schweitzer, 2013, 2017a,b; Holmbom et al., 2017; Buckley, 2018). Can extreme adventure help us analyze how these rewards are generated and evaluated? And fourth, outdoor adventure sports and recreation can be highly addictive (Buckley, 2015a; Heirene et al., 2016; Aiken et al., 2018). Are more extreme sports more highly addictive? To answer any of these questions, we need an unambiguous definition of extreme outdoor adventure sports, that does not depend in a circular way on participant psychology.

Terms such as extreme sports and adventure recreation are recent in origin. Indigenous peoples in regions of severe weather and difficult terrain, and European explorers venturing into those same areas, necessarily demonstrated psychological strength and resilience in the face of physical risk. This applies, for example, to polar regions and high mountain peaks, to untracked deserts and forests, and to the world's great rivers and oceans. It is only recently in human history, however, that individuals have begun to pursue such activities as a deliberate form of discretionary leisure. This raises the key psychological question in extreme sports (Brymer and Schweitzer, 2017a): why do some individuals voluntarily take part in such activities? What do they gain, that outweighs the very considerable costs and risks?

The psychology of participation in activities that involve excitement and physical risk is a central topic of research on outdoor sports, recreation, and tourism. In commercial adventure tourism, the focus is on providing client satisfaction through thrill or rush, while minimizing risk to the tour provider (Buckley, 2012). In individual outdoor recreation, some highly skilled expert practitioners carry out activities that involve far higher levels of risk, and require far higher levels of skill to survive (Brymer and Schweitzer, 2013, 2017a,b; Arijs et al., 2017; Feletti et al., 2017; Frühauf et al., 2017; Feletti and Brymer, 2018). It is these high-skill, high-risk activities that are commonly referred to, in both the academic and popular literature, either as adventure or extreme. Do those literatures differentiate extreme from adventure, and if so, how?

Terminologies in Different Disciplines

Extreme sports, in the particular context of outdoor adventure activities, is a rather recent term. The only published use identified by Google® Scholar prior to 1990, is in an analysis of the Hungarian health insurance system, identifying a category of excluded risks (Kereszty, 1989). The term has been used extensively, however, for at least the last quarter century, by at least three different sets of stakeholders. These three groups have used the term extreme sports with somewhat different meanings.

In the popular mass media, the term extreme carries a dramatic connotation, not specifically differentiated from adventure more broadly. This applies for, e.g., screenwriters in mass-media movies (Harlin, 1993); authors of popular autobiographical books (Bane, 1996); and journalists in popular outdoor publications (Burke, 1996; Webster, 2011; Fowler, 2016; Ferry, 2017). In the earliest of these, for example (Harlin, 1993), one of the minor characters, proposing to undertake a parachute BASE jump from a mountain under severe winter weather conditions (and subsequently forced to do so at night under gunfire), says "we like it extreme." This was a movie in the "action crime thriller" genre, with an improbable plot and equally improbable stunts. The "extreme" parachutists provided a backdrop and a small plot link. The focus was on drama, a typical example of "emotional storytelling" in mass-market movies (Cipresso and Riva, 2016). Drama, not activity, is the defining feature.

In the medical literature, and also in the legal literature of medical insurance, the terms "extreme sports" and "adventure sports" have been used jointly and interchangeably, to refer to a particular group of category of outdoor activities. In some cases these activities are listed explicitly. As noted by Brymer (2005, unpublished), each of these activities can be carried out at various degrees of difficulty, danger, and expertise. The medical literature does not consider that aspect, since its focus is on patients as they present for treatment, and on the types, frequencies, and treatment of injuries (Caine, 2012; Sharma et al., 2015; Laver et al., 2017; Caine and Provance, 2018; Ekegren et al., 2018; Emery, 2018).

Because of the focus on injuries, the meaning of extreme sports in the medical literature is quite broad (Caine, 2012; Sharma et al., 2015; Laver et al., 2017; Caine and Provance, 2018), sometimes including activities such as horse riding and mountain biking (Dodwell et al., 2010) as well as, e.g., parachuting and BASE jumping (Feletti et al., 2017); skiing and snowboarding (Graves et al., 2013; Frühauf et al., 2017); surfing (Pikora et al., 2012; Klick et al., 2016); kiteboarding and related sports (Feletti and Brymer, 2018; Morvan et al., 2018); whitewater rafting and kayaking; and climbing and mountaineering (Soulé et al., 2017a,b). This is logical from a medical perspective, since injury rates from horse riding and mountain biking are indeed high, both in total and *per capita* (Ekegren et al., 2018). Medical statistics, however, may not differentiate between a guided horse riding tour at walking speed, and a steeplechase or rodeo. They do not consider psychological experiences such as thrill, except in relation to addictive behavior.

In the academic literatures of psychology and phenomenology, the term "extreme sports" is a recent addition (Brymer, 2005, unpublished; Willig, 2008; Allman et al., 2009; Sparks, 2016, unpublished) to a longstanding literature on outdoor adventure recreation and adventure tourism (Fenz and Epstein, 1967; Brannigan and McDougall, 1983; Ewert, 1983; Hickman et al., 2016; Rantala et al., 2016; Wang and Wang, 2017). Authors such as Arijs et al. (2017), Brymer and Schweitzer (2017a,b), and Holmbom et al. (2017) have used the term extreme, in preference to adventure, for research on particularly

high-risk, high-skill activities, such as proximity wingsuit flying. Brymer (2005, unpublished) referred to "activities where a mismanaged mistake or accident would most likely result in death."

This literature has focussed principally on: the motivations of participants to undertake such activities; their psychological experiences as they do so; the transformational effects of such experiences on subsequent philosophies and lifestyles; and the analogies and correspondences with spiritual experiences (Brymer and Oades, 2009). Thrill is one aspect of these enquiries, but by no means the only one. Not all of this phenomenological literature uses the term extreme sports (Wiersma, 2014). Some authors prefer terms such as high-risk sports (Frühauf et al., 2017). Similarly, not all extreme-sports literature is phenomenological (Chang, 2017). The principal focus of this body of literature, however, has been on participant experience.

We thus have three rather different emphases on the term extreme, in three different literatures: dramatic, in the popular mass media; activity-specific, in the medical and legal literature; and psychological, in academic analyses. While these three approaches are broadly congruent or at least not directly conflicting, they are by no means identical. In particular, only the third of these, and only a small number of authors in that field, distinguish "extreme" from "adventure." Given the relationship between fear and thrill (Buckley, 2016), this distinction is an important one, if we are to use outdoor adventure and extreme sports to analyze the origins, mechanisms, and potential selective advantages of thrill as a human emotion. Here, therefore, I set out to determine whether extreme can be distinguished from adventure according to reliable and unambiguous criteria.

MATERIALS AND METHODS

I adopt a three-step approach. First, I aim to demonstrate that there is indeed a generally agreed distinction between activities considered to be extreme, and those considered to be adventurous but not extreme. To achieve this, I summarize some examples from both academic and popular published materials, including online and multimedia sources, that can be classified unequivocally into one category or the other. That is, I show that there are some outdoor adventure activities that are typically not considered extreme by any of the participants involved; and in contrast, there are some that have only been attempted by a single or a few persons, and are considered extreme by everyone aware of their existence. A few of these examples, principally in the adventure rather than the extreme category, are also supported by my own autoethnographic experience.

Second, using multiple outdoor adventure activities, I attempt to identify characteristics specific to each of those activities, that would distinguish extreme from adventurous levels. The activities examined are: surfing; skiing and snowboarding; whitewater kayaking; hang-gliding; parachute jumping; and rock and ice climbing. These are congruent with activities considered as extreme sports in the popular, medical, and psychological literatures. Of these, information on surfing, snowboarding, kayaking, and hang-gliding is derived in part from my own autoethnographic experience, as well as the literature and lore of these activities. For parachuting and climbing, I have limited personal experience, and information is derived principally from published sources. I use this information to extract general principles or features of extreme-level practice, that apply across multiple outdoor adventure activities.

Third, I test these criteria by comparing two autoethnographic examples or cases, one of them barely on the extreme side of the adventure-extreme divide, and the other barely on the adventure side. That is, in contrast to the first step outlined above, where I illustrate widely different adventurous and extreme activities in order to demonstrate that this divide exists, in this third step I illustrate activities that are close to the divide, in an attempt to pinpoint what defines it. Finally, I combine these three steps to identify minimal necessary and sufficient defining characteristics of extreme outdoor activities, and consider what this implies for the psychology of high-risk actions, lifestyles, and professions.

Each of these components includes an autoethnographic element, in addition to analyses of published literature and online materials. Autoethnographic approaches can provide particular advantages in the analysis of emotions and associated experiences (Buckley, 2015b, 2016). Autoethnography is now a well-established technique in psychological research (Anderson, 2006; Chang, 2016; Jones et al., 2016; Loftus, 2017; Winkler, 2017). For these components, I complied with: the autoethnographic research protocols put forward by Tolich (2010); the Human Ethics Research requirements and procedures of Griffith University; and the Australian National Code of Conduct for Human Ethics in Research. As an autoethnographic study, conducted in a public space, with no interviews, no inducements, no identification of any observed persons, and no experimental behavior modifications, this research is compliant with all of these protocols without the requirement for specific approvals or consents.

RESULTS

Activities With Consensus Classification as Either Adventurous or Extreme

Many adventure activities are available through guided commercial tours or non-profit recreational groups. Most of these are at a low-skill, low-risk level where participants are drawn as much by externally oriented social motivations, as by internally oriented achievement and self-esteem (Buckley, 2012, 2017, 2018; Pomfret and Bramwell, 2016; Rantala et al., 2016). Except in rare cases, the design of these activities provides large safety margins, even for inexpert and inexperienced practitioners. Examples include: guided single-day hikes or walks in easy terrain and comfortable climates; fully equipped and guided raft trips, in warm climates, down short sections of rivers that include only easily swimmable rapids; single-day sea-kayak trips in calm subtropical seas; and so on. While these may be marketed as adventure, and may indeed be perceived as adventurous by urban participants with no relevant prior experience, they would not be classified or marketed as extreme.

At the other end of the scale, there are individual exploits that have been attempted only rarely, or in some cases only once, and which would be regarded as extreme both by expert practitioners and by the general public. Through social media and the greater availability of lightweight digital video recording devices, many of these are now much more visible to the general public than was historically the case. Skiing solo across the Arctic ice toward the North Pole, swimming between moving ice floes in a survival suit (Franco, 2010), is an extreme activity in anyone's estimation. The same applies to skiing solo across Antarctica (Levy, 2017), or skiing the length of the sub-Antarctic Georgia Island, or skiing down Mount Everest (Nyznik, 1975), or speed-skiing with a kite down the mountain ranges of Alaska (Red Bull, 2014).

Similarly, surfing extremely large, powerful and dangerous waves such as Teahupo'o in Tahiti, Shipstern in Tasmania, Australia, or Nazaré in Portugal (BBC News, 2018), is possible only for the most skilled and experienced surfers, and is recognized as extreme. In whitewater kayaking, there are rivers such as the main gorge of the Yarlung Tsangpo in Tibet (Shangri-La River Expeditions, 2018), or the Inga Falls section of the Congo (Fisher, 2013), that have only ever been attempted once or twice; and others such as the Grand Canyon of the Stikine in Canada that have become legendary tests of skill and courage (Spring, 2012).

These examples, and many more, show that we can indeed recognize cases that are extreme, and cases that are merely adventurous. But these examples alone do not define the dividing line between the two. To take a few examples, is a guided climb to the summit of Mount Everest adventurous or extreme? Difficult and dangerous, certainly; but available as a purchasable product (Boukreev and De Walt, 1997). What about sky-diving onto the North Pole, or steep-slope heli-skiing in Alaska? These are also available commercially, but only to skilled and experienced clients.

What about surfing on large ocean waves such as Jaws (Peahi) in Hawai'i, or Mavericks in California, or Punta Lobos in Chile, or many others? Anyone can paddle out, but they would be foolish indeed unless they already had ample experience in powerful surf elsewhere. Indeed, in the largest surf they will also need a very experienced tow-in jet-ski driver, a specialized tow-in surfboard with footstraps, and extensive practice with both. Similar considerations apply for rivers such as some sections of the Rio Futaleufu or Rio Baker in Chile, or the Mekong, Yangtze and Salween Rivers in China. Anyone can launch a kayak, but without considerable prior experience and expertise, they may not survive. There are commercial tour operations on some of these rivers, but only in less dangerous sections, and only for appropriately qualified clients (Expediciones Chile, 2018; Last Descents River Expeditions, 2018).

So, there is a zone of uncertainty between the adventurous and the extreme. They are not distinguishable automatically. In the next section, therefore, I consider a range of different outdoor recreation activities commonly included in the literature of adventure and extreme sports, and attempt to distinguish features or levels of intensity that would distinguish the extreme from the merely adventurous.

Patterns Across Activities

Examples of adventurous and extreme options for different outdoor activities are summarized in **Table 1**. For most of these activities, the author is at intermediate adventurous level, nowhere close to extreme. For a few, the author has on occasion (and long ago) ventured slightly into the extreme bracket for some activities, but barely, rarely, and sometimes inadvertently. In whitewater kayaking, the author has never been routinely capable of tackling rivers and rapids considered as extreme, but has, on one or two occasions, paddled rarely run and dangerous rapids that might be considered in that category (Van Beek, 1998). Similarly, the author's overall kiteboarding skills are intermediate at best, but on a few occasions have included cyclone swells larger than 7 m in size.

Examples from hang-gliding include: cliff takeoffs, night flights, one storm front, and aerobatic maneuvers known as wingovers. Cliff takeoffs are risky because they involve running off cliffs blind, at full speed, without knowing what airflow one will encounter. Even with a spotter to watch the movement of vegetation below the cliff as an indicator of airflow, and assistants to steady the hang-glider wing-tips before the run, this is a relatively high-risk move. The author has witnessed one accidental death during a cliff take-off. Night flights were at a ridge-soaring site with a reliable wind and an easy top-landing site, using headlights from two parked cars to mark the cliff edge. This is fine, as long as nothing goes wrong. The storm-front case was not deliberate, but it involved emergency maneuvers to survive a very powerful and turbulent wind. Wingovers are described in the next section.

General features of extreme *cf.* adventurous activities, extracted from the activities in **Table 1**, are listed in **Table 2**. In summary, extreme level activities involve higher skill, focus, and risk. Adventurous activities also involve skill and risk, but if the skill proves inadequate, the consequences are unlikely to prove fatal, unless the participant is unlucky. Extreme activities involve the continuous application of highest-level skills and concentration in order to avoid any error, and any failure is likely to prove fatal, unless the participant is especially lucky. In many activities, any error is likely to cause an immediate and irremediable disaster. Falling on a free solo climb, or hitting a cliff during proximity wingsuit flying, commonly permits no recovery or rescue. This provides a distinction that corresponds to that adopted in previous phenomenological research (Brymer, 2005, unpublished), but is itself independent of the psychology of the participants. We can therefore use that definition to examine the psychology of thrill, without risk of circularity.

Illustrations at the Dividing Point

If we define extreme sports through the consequences of any mistake, that raises two further issues. The first is that participants in some voluntary outdoor adventure activities sometimes die not through any mistake of their own, but because of unexpected adverse environmental circumstances that occurred despite accurate prior assessment of low probability. The description by Fiennes (2003) of Scott's 1911–1912 expedition to the Antarctic provides a carefully analyzed example,

TABLE 1 | Adventurous cf. extreme, comparison across multiple outdoor activities.

Activity	Adventurous (including tours)	Extreme (individual only)
Surf	Moderate to large sized waves, especially those involving travel to a remote site, but generally in warm water climates, with at least some water depth over seafloor in front of breaking wave.	Very large, shallow, fast, and/or stepped waves, especially over reef or rocky seafloor, and/or hollowing out to drain water from ocean in front of break, and/or in cold water climates. Surfing at night, or in areas with high shark risk, or with frequent floating logs or other obstacles.
Snowboard, ski, heli-ski	Long, steep and/or sloughing powder runs; especially at high altitude; especially with tree wells, rocks or cliffs, but with expert guidance to avoid obstacles; and especially with avalanche risk, but only with avalanche control practices; jumps, but of moderate height, soft and steeply sloping landings, no risk of hitting rocks.	Inescapable couloirs; blind runs down steep and potentially cliffed terrain; runs on sloughing slopes where rider must outrun or outflank sliding snow; runs on avalanche-prone terrain without prior control via bombing; jumps and drops of considerable height, with very precise take-off and landing required to avoid rocks or other obstacles.
Whitewater kayak	Rapids up to Grade IV+ to V, for suitably skilled and experienced paddlers, as long as they are either scoutable or have been run previously, and do not incorporate potentially fatal obstacles, hydraulic features, or large waterfalls.	Rapids at Grade V+ or higher; blind runs through inescapable gorges; large waterfalls; potentially fatal hydraulic features such as inescapable undercuts, strainers, or whirlpools; unavoidable weirs, stoppers, or ledge holes.
Hang gliding, parapenting	Tandem flight in ridge-soaring conditions with steady winds, gentle take-off, and straightforward landings; solo flight by appropriately qualified pilots, including cross-country thermal flights, but only using cumulus cloud streets; hill take-offs from smoothly rounded terrain features, and with bomb-out landing sites in case of need.	Sharp-edge cliff take-offs into strong rising thermals; take-offs from structures such as ramps, bridges and buildings; high-altitude flight; flight in violently powerful thermals; flight during storms; flight using lift from storm fronts, wave clouds, rotating clouds, etc.; inverted and semi-inverted aerobatic maneuvers such as loops and wingovers; cross-country flight over terrain with no landing sites; night flight using landing lights.
Kiteboarding	Winds 10–35 knots (depending on kite size); surf 0–5 m; jumps $<$ 10 m vertical; variety of maneuvers on water or in air, but with bail-out options if they fail.	Winds $>$ 40 knots (depending on kite size); surf $>$ 5 m; jumps $>$ 10 m vertical; high-risk maneuvers such as 360° kite loops; speed-riding (kite plus skis or snowboard on very steep mountain terrain).
Parachuting	Tandem jumps, solo jumps for adequately qualified parachutists; moderate altitude, calm or low wind, daylight hours, safe approaches to landing sites.	BASE jumps, wingsuit proximity flying, high winds, high altitude drops, night jumps, jumps in severe climatic conditions and particularly remote areas (e.g., Arctic); dangerous approaches to landing sites.
Climbing	Rock and ice climbing with adequate skills, equipment and protection, typically grades $\leq$ 5.10 (depending on climber expertise); sites with safe and straightforward access; weather fine to moderate	Free solos, some bouldering, multi-day multi-pitch big-wall climbs; free-solo vertical or overhanging ice climbs, frozen waterfall climbs; high-graded climbs (depending on climber expertise); remote sites, sites with difficult access and recovery; severe weather conditions.

TABLE 2 | General distinguishing features of extreme cf. adventurous activity levels.

Characteristic	Adventurous level	Extreme level
Available commercially	Yes, can be undertaken either as tour client, or as a private individual	No, can be carried out only highly skilled individuals, independently
Equipment	Own or rented, standard, can be second-hand	Own, best available, often customized
Skill needed to survive	Low (tour) to moderate (solo)	Very advanced, world class
Focus and concentration	Moderate, intermittent	Intense and continuous
Duration of crux moves	Few, short crux points during session	Entire session is continuous succession of crux moves
Consequences of error	Struggle, possible injury	Immediate death likely
Likelihood of death, if error	Unlikely, death only if very unlucky	Likely, would be lucky to survive
Attitude to death	Strongly averse, no expectation	Live to the full, prepared to die

although of course that was a scientific exploration rather than a recreational activity. The five men who died on their return from the South Pole were overcome, ultimately, by an unlikely set of weather conditions, that they had no means of predicting or preparing for. Similarly, the death of famed Russian high-altitude mountaineer Anatoly Boukreev in an avalanche was not through any mistake of his own. The factors likely to lead to avalanches are predictable, but the actual occurrence of any avalanche is stochastic. The longer that any individual spends in avalanche-prone terrain, the higher the cumulative risk of being caught by one, irrespective of expertise.

These examples, however, do not conflict with the definition of extreme sports as derived above. There are well-known examples involving multiple deaths, where different individuals, or indeed adventure tourism guides and companies, made different assessments of risks and rewards. These include cases such as deaths during commercial climbs (Boukreev and De Walt, 1997) or canyoning tours (Lashmar and Karacs, 1999).

The second issue is that some individuals may die through accidents even during low-risk adventure activities, even where the activity is routine and oft-repeated, and even where other participants were uninjured. This, however, does not imply that those activities are extreme, but rather that particular individuals were unlucky, or in some cases behaved foolishly. That is, I argue that the distinction drawn here between extreme and adventure sports, based on the likely fatal consequences of any mistake, is still valid overall, even though: (a) some participants in extreme activities die without any mistakes; and (b) some participants in adventure activities die even though the activities are not extreme.

In support of this argument, and to illustrate the precise dividing line between adventure and extreme, I now present one autoethnographic incident that could be judged as (barely) extreme, and one that could be judged as (barely) adventurous. I should emphasize that there are very many activities and participants far more extreme than this example, but that I do not have personal experience of them. I describe these incidents in some detail, in order to convey the sensations experienced from the participant perspective. This is the same approach as that adopted by Buckley (2018), who used one rapid on one river to illustrate the type of incident available to identify broader scale patterns.

The first example is from hang-gliding. It took place many decades ago. A hang-glider is a double-surface aerofoil wing, constructed from fabric over a frame of aluminum alloy tubing braced by wires under tension. The wing exerts substantial drag, and maximum speeds are low compare to cockpit gliders. Hang-gliders have no moving aerofoil surfaces, and they are steered solely by weight shift. The pilot hangs in a harness under the wing, grasping a control bar that forms part of the rigid frame of the hang-glider. If the pilot pushes the bar to left or right, the pilot's weight causes the wing to bank, initiating a turn. If the pilot pushes the bar forward or pulls it back, the pilot's weight causes the wing to turn upward or downward, respectively, initiating a stall or dive. Flight angle, speed and direction are monitored by the pilot's senses, by watching the ground, listening to the sound of air over the wing, and feeling both airflow and gravitational forces on the body.

There are two principal flight strategies: cross-country flight using thermal lift, with radio contact to a pick-up vehicle; or "park'n'play" ridge-soaring flight, using up-drafts along a hill or ridge, at a site allowing take-off and landing at the same location. During ridge soaring, pilots can easily recover altitude, and can therefore practice different maneuvers, such as flying at different speeds, and making tighter or more open turns. For example, a pilot can first gain the maximum altitude available by ridge soaring, and then bank sharply into a series of tight 360° turns, gradually losing altitude in the process, and straightening out into level flight once at the altitude of the ridge, but well in front of it. This maneuver creates substantial G forces and requires concentration, but is relatively safe.

A more risky maneuver is a wingover, a partially inverted aerobatic move. To achieve this, the pilot first gains altitude, and then puts the hang-glider into a steep dive to gain speed and momentum. Once maximum safe speed is gained, the pilot pushes the control bar forward so the wing begins to fly sharply upward, and then banks the wing hard either to left or right, so as to create a steep turn from upward flight. If carried out successfully, this creates a turn where the wing is banked at more than 90° to horizontal. That is, it is a partially inverted turn like a diagonal loop, half-way between a steep turn in normal flight, and a fully inverted loop. A few pilots have indeed completed full loops in hang-gliders, but not using normal flying harnesses.

A wingover involves significant risks. If the pilot does not have sufficient speed on the short section of upward flight, the wing will stall while inverted, causing a crash. Most hang-glider wings can recover from a soft stall during level flight, although there have been fatal accidents when they did not. They cannot, however, recover from a stall when inverted. I did once find myself falling from the sky on top of an inverted hang-glider, and it did not recover, but crashed upside down. Fortunately, on that occasion the distance fallen was small, since I had merely crashed into the top of a tall tree, and fallen out backward. But it does seem that in a hang-glider, stalled inverted flight is unrecoverable.

In a hang-glider wingover, airspeed drops rapidly during the brief period of steep upward flight. The pilot must make an instant judgment, based only on the sound and feeling of airflow, whether or not they have adequate airspeed to support a fully banked turn, allowing for further loss of airspeed during the turn itself. If they do, they can perform a successful wingover. If they do not, they will probably suffer an inverted stall and fatal crash. Once the wingover turn has been initiated, there is no going back.

During an interval of a few moments, therefore, the pilot goes from: (a) diving at high speed, able to see the ground diagonally below and in front; to (b) flying steeply upward, conscious of rapidly decreasing speed but not looking at the ground; (c) a decisive control move, to pull the wing into a sharp bank; (d) the top of the wingover, where airspeed falls almost to zero, the wing falls still and quiet as in a stall, and the ground is visible upside down above one's head; (e) a near-vertical dive toward the ground at rapidly accelerating speed; and finally (f), pulling out into level flight. The moment of commitment is (c), but the moment determining the outcome is (d), when it is already too late to change your mind.

I tried these a number of times in the mid 1970s. Most were uneventful, though scary. But on one occasion, at the inverted moment (d) as above, my wing actually did stall. Everything went silent, the flying surfaces lost tension, and I heard the sound of the fabric slapping hard against the internal frame. That is an indicator of a hard stall: as may occur, for example, when flying suddenly from calm air into a strongly lifting thermal. The wing dived vertically and began to spin at the same time. Fortunately, it straightened from the spin, and pulled out of the dive the right way up, rather than inverted. So I survived, but only through good fortune. After that incident, I did not attempt any more wingovers.

There are three key considerations in this example. The first is that it was not merely an adventurous activity where something unfortunately went wrong. A wingover is a deliberate move. The second is that the participant knows well that any error is likely to prove fatal, and that they are relying completely on their own skill to avoid any such error. And the third is that once the move has been made, there is no going back. If an error is indeed made,

as it was on the occasion described, survival is purely a matter of luck. Therefore, if a line can be drawn between the adventurous and the extreme, we could argue that this event was just on the extreme side.

The second example is from snowboarding. It was during a commercial heli-ski tour, when I was the only snowboarder in the group. In mixed heli groups of skiers and boarders, it is common to let the skiers descend first, since they want to lay down perfect figure-8 tracks on untouched snow. Snowboarders, in contrast, have different ambitions. On this occasion, we were at the top of a large open bowl, running out to a broad shelf, and then dropping in a further slope. To our right was a cornice. Our guide went first, and the skiers followed. And then it was my turn.

I was standing by myself with the whole open slope below me, fresh powder except for a few new ski tracks. My plan was to drop straight downslope, gain speed, and then make a big swooping toe-side turn (i.e., toes pointing downward) to the right, bringing me up under the cornice. There I planned to make a sharp heel-side snap turn back downhill. These are the snowboard equivalents of a bottom turn and cutback when surfing. A large high-speed toe-side bottom turn on powder snow, which may have a radius of 50 m or more, generates powerful G-forces, like a massive weight through one's knees, and this lets one lay one's body almost flat to the snow surface. A sudden heel-side snap turn on powder snow throws the full bottom face of the board into the snow, so hard that it carves out a big chunk of snow. These moves are not difficult, but they are fun.

On this occasion, they worked perfectly, and I was heading back downslope, when I suddenly happened to notice that the snow below me had an unusual surface shape, like little waves. I had never seen that before. As I began to wonder how they had formed, I saw that they were getting bigger. At that instant, I realized that I had started an avalanche under the cornice, and the waves were the snow compressing and buckling under the weight of moving snow above and behind me. At the same moment as this realization, I saw the snow surface in front of me divide into a myriad tiny cracks, like a fine network.

I was already riding fast, and I crouched, leaned forward and turned slightly to the left, hoping to outrun the falling snow and escape the main path. As I did so, I saw in front of me, a deep and widening trough in the snow, like the ground yawning during an earthquake. I kicked my back foot down, and jumped the gap at full speed. I was back on firm snow, but from the corner of my right eye I could see house-sized blocks of snow tumbling and accelerating downhill. Ahead I could see a ridge, and I was riding for it at maximum speed. I glanced downslope to check that the skiers were safe, and saw the avalanche halt at the bottom of the bowl, without running across the shelf. They were safe. But from far below me I heard our guide's voice. "Doooooonnnn't stooooppppp!" I didn't.

This was a reputable commercial tour, at an often-used site. We had an experienced guide, and we had taken avalanche safety precautions. It was a large, deep, and violent avalanche, however, powerful enough to have caused severe physical trauma, if I had been caught. In addition, there was nobody upslope to track my path and get quickly to the point where avalanche beacons, probes and snow shovels could have been used. We had a helicopter, but it was shuttling another group, in radio contact but out of sight. Had I been caught, therefore, I should have been lucky to have survived. The risk, however, was derived from an unintended accidental event. The actual snowboarding required was no more difficult than usual. Once again, if a line can be drawn between the adventurous and the extreme, we could argue that this event was on the non-extreme, adventurous side.

DISCUSSION

Adventurousness, it has been argued (Buckley, 2017), is an individual concept. An outdoor tour may be a lifetime's most adventurous experience for some of the clients, but a daily routine for the guides. In addition, adventurousness is a subjective concept. An individual who is skilled and fearless at one outdoor activity, may still be a frightened novice at a different activity. How do these considerations apply to outdoor activities at the extreme level? As conceptualized above, extreme activities involve continuous application of highest-level skills and concentration, with any lapse likely to prove fatal. That is, it is the perceptions and actions of the individual participant, moment by moment, that save them from death; and these actions and perceptions are only possible through high-level skill and experience, possessed by few participants. For most participants, though not all, this also involves overcoming fear (Brymer and Schweitzer, 2013, 2017a,b; Buckley, 2016), through remarkable levels of emotional calm, confidence and control.

Is this an objective distinction, independent of individual participants; or a subjective distinction, depending on the attitude of the individual? The chance of making a mistake is influenced strongly by the skill of the individual, as well as the features of the physical environmental setting; but the consequences of any such mistake are influenced only weakly by individual skill, and principally by the physical environment. At the adventurous level, less skilled as well as more skilled participants can commonly survive a fall, wipe-out or corresponding incident. At the extreme level, even the most skilled participants are unlikely to survive. And that is precisely why only the most skilled individuals can participate at extreme levels: there is no room for error, and no second chance. That indicates that, in contrast to the subjective definition of adventurousness, extreme outdoor activities can be defined in objective terms, following the approach first put forward by Brymer (2005, unpublished).

The definition that I propose in using extreme sports to analyze thrill, therefore, reflects past usage in the psychological literature (Brymer, 2005, unpublished) rather than the medical or popular literatures. It relies strongly on objective risk of death in the case of any participant error; or in an equivalent formulation from the reverse perspective, on the critical requirement for continuous exercise of high-level participant skill in order to avoid fatal accidents. It draws a qualitative rather than quantitative distinction between extreme and non-extreme adventure. This contrasts with previous analyses that have conceptualized extreme as one end of a continuum of

adventurous activities. The "adventure experience paradigm" (Priest and Bunting, 1993; Jones et al., 2003) argues for a five-step continuum of risk cf. competence that includes "misadventure" and "devastation and disaster." The formulation adopted here differs from that paradigm. Contrary to that model, I argue that in low-risk adventure, competence is not a critical predictor of outcomes in the event of error. The definition adopted here also contrasts with previous analyses that have used multiple simultaneous criteria, of which risk is only one, to distinguish extreme from adventurous (Lebeau and Sides, 2015). Those approaches include cultural, commercial, and psychological components, contrary to the definition established here.

The definition adopted here contains two key components. The first is that extreme is distinguished from non-extreme adventure by risk rather than activity. In contrast to commercial adventure tourism, extreme outdoor sports involve high physical risk. It is the level of risk, not the type of activity, that distinguishes extreme from run-of-the-mill adventure. The second is that risk is defined as the product of probability and consequences, and the high risk in extreme outdoor sports is high because the consequences of error are severe or fatal. The probability must therefore be low, or the activity could not be carried out at all; and it is low specifically because of the high skill, training, experience, focus and concentration of participants. Commonplace safety measures used during adventure-level activities generally cannot be used during extreme-level activities. They rely purely on participants' skill, with zero errors.

Both adventurous and extreme outdoor activities may require fitness, training, practice, skill, and split-second perceptions, decisions and actions. At the adventurous level, however, a participant can afford to make mistakes, and still survive. At the extreme level, a single mistake, which can occur in hundredths of a second in some activities, is likely to be fatal. Participants at extreme level cannot afford any mistakes, at all. Therefore, they need the highest levels of skill, capability, control, focus, and judgment. This also sets a psychological distinction between outdoor adventure athletes, and outdoor extreme athletes. The former are adding to the richness of their lives, perhaps accepting a non-negligible risk of injury, but only a very small additional risk of death. The latter believe that life is worth living only if it is lived to the absolute fullest, even at the frequent and significant risk of death. Both experience thrill, but surely, at very different levels. At the adventure level, the thrill is temporary. At the extreme level, it is transformational. This is a distinction deserving of further research.

AUTHOR CONTRIBUTIONS

RB designed and conducted the research and wrote the article.

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Antecedents of Exercise Dependence in Ultra-Endurance Sports: Reduced Basic Need Satisfaction and Avoidance-Motivated Self-Control

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Initiating and maintaining sports and exercise behavior are usually discussed in terms of strategies for promoting health. In the present study, we analyzed a sample of extreme endurance sport athletes and set out to predict exercise addiction, which is a facet of a sport-related health risk. We therefore draw on self-determination theory (Deci and Ryan, 1985, 2000), according to which low basic psychological need satisfaction can lead to excessive compensatory behavior. We aim to disentangle the effects of need satisfaction in the activity itself (exercising) and outside the activity (work/leisure) on exercise addiction. Furthermore, we propose anxious self-motivation as a mediator and tested whether it links low basic need satisfaction with exercise dependence. A correlational study with 323 multi-triathlon athletes confirmed our hypothesis that need satisfaction in work/leisure (but not in sports) is negatively related to exercise addiction. Furthermore, only need for competence in both domains (sport, work/leisure) is associated with anxious self-motivation. Mediation models showed that low competence satisfaction leads to anxious self-motivation that in turn predicts exercise addiction. The results are discussed critically in terms of their practical and theoretical implications for promoting health through sport and exercise.

Keywords: exercise dependence, self-determination theory, need for competence satisfaction, self-control, endurance sports

INTRODUCTION

Regular exercise is known to have a positive influence on psychological and physiological health. It fosters emotional well-being (Fox et al., 2006), reduces depression and anxiety (Mutrie, 2000; Wegner et al., 2014; Budde and Wegner, 2018) and is associated with a reduced probability of coronary heart disease and with lower mortality (Bouchard et al., 2000; Katzmarzyk, 2006). Thus, it is no surprise that sport and exercise are discussed as health-promoting strategies. However, what is rarely considered in the literature on health-related effects of sports are the negative consequences of sport. One example is when sports and exercise behavior are performed excessively.

The present research has three aims. First, we want to explain exercise addiction as a sport-related health risk by using another psychological concept which has been found to be linked to health and health impairment: the satisfaction of basic psychological needs (Deci and Ryan, 1985, 2000; Kasser and Ryan, 1999; Reis et al., 2000; Ryan et al., 2010; Ng et al., 2011; Vansteenkiste and Ryan, 2013). Our second aim is to disentangle the effects of basic need satisfaction by examining the overall score as well as the three sub-scores (autonomy, competence, relatedness) and by considering need satisfaction in the exercise activity itself as well as outside the activity (work/leisure). Our third aim is to discuss the role of avoidance-oriented forms of self-control as an explanation for the link between psychological need thwarting and exercise dependence. Anxious self-motivation (Kuhl, 2000), which is such an avoidance-motivated facet of self-control, could serve as a mechanism that links low basic psychological need satisfaction (e.g., need for competence satisfaction) with exercise dependence. Athletes who experience low need satisfaction in other life domains and are anxiously self-motivated may tend to participate in excessive sport because this life domain may promise controllable satisfaction of different basic psychological needs like competence or autonomy.

Exercise Dependence

Exercise dependence is defined as "a craving for leisure-time physical activity, resulting in uncontrollable excessive exercise behavior that manifests in physiological (e.g., tolerance/withdrawal) and/or psychological (e.g., anxiety, depression) symptoms" (Hausenblas and Downs, 2002, p. 90). Referring to criteria for substance abuse defined in the Diagnostic and Statistical Manual of Mental Disorder (DSM– IV; American Psychiatric Association, 2000), Griffith (1996, 2002) has suggested six components that contribute to behavior addiction such as exercise dependence. These components are *salience* (exercising is ever-present in a person's life), *tolerance* (the person has to increase the bouts of exercise in order to achieve its positive effects again), *regulation of mood* (use of exercising as a strategy for regulating emotions), *symptoms of withdrawal* (e.g., irritability, a bad mood), *conflicts* with other persons (e.g., demands of family, friends), with other activities (e.g., less time for job) and within the person (conflicts between the impulse to exercise and the wish to free oneself from the dependence), and *relapse* (quick return to the same pattern of behavior and intensity even after remaining abstinent for many years). Exercise dependence is often used interchangeably with the term exercise addiction (Szabo et al., 2018).

Exercise dependence has been found to be associated with low self-esteem, a high need for achievement (Cohen, 1995; Cook, 1996; Szabo et al., 2018), weight concerns (Davis, 1990), interpersonal problems (Rudy and Estok, 1983), social dependency (Smith et al., 1998), high negative affect after missing a workout, and the continuation of exercising despite injuries (Anshel, 1991). Because exercise dependence is characterized by an increased tolerance to physical stress and by excessive exercise behavior, it can also lead to severe physical damage such as reversible, or even irreversible, health impairment and mortality (Cumella, 2005). In summary, excessive exercise has serious detrimental physical and psychological consequences (Hall et al., 2007). It is therefore extremely important to analyze its antecedents.

Our focus in the present research is on psychological antecedents of exercise addiction as compensation of psychological need thwarting in other life domains. We assume that ultra-endurance athletes adhere to an excessive sport program because basic psychological needs like experience feelings of competence, social relatedness with others, or feeling self-determined in their everyday life (e.g., in their professional life) are not satisfied.

Basic Psychological Needs Thwarting and the Compensation Effect

The self-determination theory provides a general framework on psychological functioning and how it affects individuals' effort, agency, and commitment in life. According to Deci and Ryan's (1985, 2000) self-determination theory, three innate psychological nutriments are essential for the individuals' psychological, social, and physical well-being. These are the basic psychological needs for competence, autonomy, and social relatedness. The need for *competence* is the desire to experience feelings of competence and the mastery of challenging tasks (e.g., Deci and Ryan, 2000; see also White, 1959). Need for *autonomy* is the constant desire to experience volition control and self-ownership (deCharms, 1968). The need for *social relatedness* is the attempt to feel socially connected to other people (Baumeister and Leary, 1995; Deci and Ryan, 2000).

Several studies in different domains of life have confirmed the theoretical assumption that the satisfaction of basic psychological needs (e.g., through environments that support those needs) has positive consequences. Basic need satisfaction, for example, leads to emotional well-being (Parfitt et al., 2000; Edmunds et al., 2007; Aldrup et al., 2017) and motivation (Wilson et al., 2007; Devloo et al., 2015) in sports (further examples of the application of basic need theory in sports: Mullan et al., 1997; Pelletier and Sarrazin, 2007; Vallerand, 2007; Lundqvist and Raglin, 2015; see Hagger and Chatzisarantis, 2007, for a summary).

Most importantly for the present research question, Deci and Ryan (2000; see also Ryan et al., 1995) assume that when basic needs are not fulfilled, people may try to cope in maladaptive ways. Two examples of this are need substitutes and rigid behavior (Deci and Ryan, 2000). Regarding the former, individuals with low need satisfaction develop need *substitutes* (prestigious objects, social approval), which might improve their subjective well-being in the short run but fail to contribute to their well-being in the long run (which is only achieved through stronger basic need satisfaction) (e.g., Vansteenkiste et al., 2007; Soenens et al., 2008). *Rigid behavior* is defined as avoidance of changes in behavioral contingencies according to one's own values (Hayes et al., 1999). Such rigid behavior like exaggerated perfectionism in one's professional life, might also be beneficial in the short run, because it provides structure and is associated with predictability (Shafran and Mansell, 2001).

However, it also fails to satisfy basic psychological needs and consequently is an important predictor of ill-being. One example of a rigid pattern of behavior as a response to impaired need satisfaction is restricted eating. Eating disorders represent a comorbidity (Szabo et al., 2018) of exercise dependence and the relationship between unfulfilled needs and problems associated with restricted eating is empirically supported (Thogersen-Ntoumani and Ntoumanis, 2007; Stok et al., 2010; Froreich et al., 2017). Summarizing the main assumptions of this research field, people often try to compensate for low basic need satisfaction in important life domains by trying to reach higher need satisfaction in other life domains. In the worst case, this can be done through restricted eating, for example, or – as we suggest in our present research – by exercising excessively. Restricted eating might be a person's attempt to compensate for low *autonomy* satisfaction (Stok et al., 2010). For example, individuals try to gain control over their hunger in order to experience autonomy (which they do not experience in other life domains). We assume that exercising excessively also results from basic need thwarting. This should be especially true for basic need for competence satisfaction. We hypothesize that a highly achievement-oriented setting such as extreme endurance sport is a person's attempt to compensate for low basic need for *competence* satisfaction in other life domains (e.g., at the work place, in leisure time). For example, individuals try to improve their running time and enjoy training progress in order to overcome need for competence frustration in their professional lives. Similar theoretical considerations might have caused Lalande et al. (2017) to derive their hypotheses. They suggest that two distinct sources of need satisfaction have to be distinguished. Need satisfaction inside and outside the activity. In accordance with their hypotheses the authors found that need satisfaction inside an activity (doing sports, doing music) leads to harmonious passion (a balanced type of passion associated with positive consequences for motivation and well-being), whereas low need satisfaction outside the activity leads to a compensatory striving which results in an unhealthy type of passion in the activity called obsessive passion (for details about the differentiation of obsessive and harmonious passion see Vallerand, 2008). Although the studies conducted by Lalande et al. (2017) encourage our line of reasoning outlined above, they differ with regard to the central concept (passion rather than exercise dependence) and with regard to the range of analyzed activities [broad range in Lalande et al.'s (2017) study, among them: music, basketball, arts and crafts, reading, work]. In the present research we focus on the domain of sport and, most importantly, we analyze extreme behavior (extreme endurance sport).

Furthermore, rather than combining the items of the three needs into an overall measure of need satisfaction (see Lalande et al., 2017), we aim to disentangle the effects of the three needs. As introduced above, we assume that the basic need for competence plays a crucial role in the achievement-oriented activity (extreme endurance sport) which we analyzed in our study. As a further theoretical extension of previous research, we aim to shed light on the mechanism that links low basic need satisfaction with exercise dependence.

Anxious Self-Motivation as a Mediator in the Basic Need Exercise Dependence Relationship

As already stated above, we assume that low basic need for competence satisfaction outside exercising might be an antecedent of exercise dependence. However, in contrast to previous studies on the effects of need frustration that mainly focussed on facets of well-being (e.g., well-being, vitality; see above), the core of exercise dependence is the (maladaptive) persistence in *behavior*. Although exercise addiction is accompanied by impairment of well-being, its core feature is excessive behavior. Therefore, we assume that a motivational variable is necessary to link the frustration of felt competence, relatedness and autonomy with the initiation and maintenance of excessive behavior. We assume that this variable is *anxious self-motivation* (Kuhl, 2000) due to the following theoretical considerations. According to Kuhl's (2000) theory of volition, low basic need satisfaction is a state of stress and frustration, which is assumed to be related to reduced utilization of volitional functions. Among the consequences of volitional inhibition, such as *energy deficit* and *heightened proneness to external control* (which might elicit passivity, but not active coping), Kuhl and Fuhrmann (1998, p. 29) suggest "a tendency to engage in negative motivation control in terms of anticipating negative consequences of not acting or not reaching the goal." In their *Volitional Component Inventory* (short form; German version), the authors call this facet of self-control *anxious self-motivation*, meaning that fear motivates the investment of time and effort in order to prevent failure or further frustration and stress. A similar anxiety-driven mechanism has been proposed in sport, for example by Conroy and Coatsworth (2007) who empirically confirmed that basic need frustration is responsible for the fear of failure of youth swimmers. Hall et al. (2007) further showed that maladaptive forms of achievement orientation (e.g., overstriving, neurotic perfectionism) are predictors of obligatory exercise.

Concisely stated, basic need frustration leads to an avoidance-oriented form of self-control which aims to avoid negative states (e.g., low need satisfaction), but activates rather than inhibits behavior (engagement, excessive behavior rather than passivity). In statistical terms and referred to the domain of extreme endurance sport, we assumed that anxious self-motivation mediates the relationship between athletes' basic need for competence frustration and exercise dependence.

These considerations are also in agreement with SDT theorizing (Ryan and Deci, 2000) which suggests that when basic needs are thwarted, behavior is guided by less autonomous and hence maladaptive forms of regulation (e.g., avoidance rather than approach regulation). Like other forms of avoidance motivation (see Elliot, 2008), anxious self-motivation in turn leads to behavior aimed at avoiding undesired states. These undesired states may be experienced in the work domain or the person's private life. As already stated above, anxious self-motivation may then guide a person's behavior toward strong involvement in excessive compensatory exercise, to avoid feelings of reduced competence.

Summing up we derived the following hypotheses from our reasoning outlined above. Our first hypothesis is that low need satisfaction in one's professional and private life may lead to excessive involvement in the domain of endurance sports, in which feelings of competence may seem to be relatively easy to attain (progress and success mainly depend on oneself and are easy to measure). Our second hypothesis concerning the mechanism is that low need satisfaction activates anxious self-motivation, which in turn results in an dependence to the exercise activity. Furthermore, we assume that Hypotheses 1 and 2 are especially true for the basic need for competence due to the performance-oriented nature of extreme endurance sports.

MATERIALS AND METHODS

Participants and Procedure

We recruited a sample of 323 ultra-endurance athletes (269 men) with a mean age of 45.72 years (SD = 9.20) via the mailing lists of ultra-endurance events and through personal contacts. We selected a sample of ultra-endurance athletes who take part in competitions exceeding 6 h in duration. Forty-nine participants were multiple triathletes, 131 described themselves as long-distance runners, 14 as long-distance swimmers, and 91 as long-distance cyclists. Thirty-eight participants chose the response "other kinds of endurance sports." The inclusion criterion was that they had participated in an ultra-endurance event (defined as a competition that exceeds 6 h in duration). Because we did not find differences between the different types of sport, we used the entire sample for the analyses reported below.

Participants filled in an anonymous web survey (LimeSurvey) including questions on their age, sex, and their main sports. Furthermore, it contained the basic psychological need satisfaction measures for professional and private life, and for sports. In order to separate the two basic need measures from another, we used 16 filler items, which are unrelated to the present research question (FKS, Rheinberg et al., 2003). Furthermore, the web survey contains the self-control measure, and the exercise dependence measure.

Measures

In order to measure the *basic psychological needs* for competence, social relatedness and autonomy satisfaction in professional and private life and in sports, we used a German translation of the Balanced Measure of Psychological Needs Scale (BMPN; Sheldon and Hilpert, 2012; German translation by the first author). Each scale consists of six items (e.g., competence: *"I was successful at completing difficult tasks and projects,"* social relatedness: "*I felt in touch with people who care for me, and whom I care for,*" autonomy: *"I was free to do things my own way"*). Participants were first asked to relate the statements to their extreme endurance sport activity and then (after the filler items) to their professional and private life outside sports. Instructions to the second questionnaire were that we (the experimenters) are well aware that filling in the same questionnaire twice might be a bit boring or annoyingly, but that we ask them to fill the questionnaire thoroughly and with regard to the domains of work and other leisure time activities (expect sports). They rated their agreement with the statements using a 7-point rating scale ranging from 1 (strongly disagree) to 7 (strongly agree). We computed a basic need for competence satisfaction, need for relatedness satisfaction and need for autonomy satisfaction score as well as an overall need satisfaction score (mean of the three subscales), separately for the domains sport and work/private life. Whereas the Cronbach's Alphas for need satisfaction at work/private life were sufficiently high (competence: 0.72; relatedness: 0.69; autonomy: 0.79; overall score: 0.84), the Alphas were lower for basic need satisfaction in sports (competence: 0.50; relatedness: 0.55; autonomy: 0.61; overall score: 0.72).

In order to assess anxious self-motivation, we used the *anxiety-oriented self-control* (named *goal orientation without anxiety* in the original scale; *reversed* items) subscale of the Volitional Components Inventory (German version: Selbststeuerungsinventar, SSI-K3; Kuhl and Fuhrmann, 1998; Kuhl and Alsleben, 2009). Participants used a 4-point rating scale (1: strongly disagree – 4: strongly agree) to indicate their agreement with statements such as "*In order to motivate myself, I often imagine what would happen if I didn't finish the task on time*." The means of participant's responses to the four items were used as their score for anxious self-motivation (Cronbach's Alpha = 0.63).

Exercise dependence was assessed using the 6-item Exercise Addiction Inventory (Terry et al., 2004). It consists of components of behavioral dependence suggested by Griffith (1996) (see above) (e.g., salience: "*Exercise is the most important thing in my life*"; tolerance: "*Over time I have increased the amount of exercise I do in a day*"; withdrawal symptoms: "*If I have to miss an exercise session, I feel moody and irritable*"). Participants indicated their agreement with the statements using a 5-point rating scale ranging from 1 (strongly disagree) to 5 (strongly agree). The overall score for exercise addiction (mean of all items) was sufficiently reliable, with Cronbach's alpha = 0.72. At a cut-off score of 24 (top 15%) athletes are considered at-risk of exercise addiction (Terry et al., 2004).

RESULTS

Preliminary Analyses, Descriptive Statistics and Correlations

Preliminary analyses showed that the participants' age did not influence the results reported below. Men and women did not differ in any of the assessed variables and the participants' gender did not influence the reported results.

Table 1 shows the means and standard deviations of the relevant variables and their inter-correlations. As can be seen, the basic need scores in sports and at the workplace/leisure time are highly correlated with each other (r's between 0.17 and 0.84, all p's < 0.01). Furthermore, basic needs for competence in both domains are significantly negatively correlated with anxious self-motivation ($r = -0.21$ for sport and $r = -0.20$ for work/leisure time). Differences between the sport and the work/leisure domains were found in the relationship with exercise addiction. As predicted, only basic need for social relatedness ($r = -0.16$,

TABLE 1 | Descriptive statistics and correlations (Pearson, two-tailed, $N = 323$).

	1	2	3	4	5	6	7	8	9	10	*M*	*SD*
1 Competence_Sport	–	0.41***	0.37***	0.78***	0.52***	0.23***	0.18**	0.38***	−0.21***	−0.06	5.60	0.79
2 Relatedness_Sport		–	0.26***	0.78***	0.33***	0.46***	0.20**	0.41***	0.05	−0.08	5.42	0.91
3 Autonomy_Sport			–	0.67***	0.24***	0.26***	0.28***	0.33***	−0.01	−0.01	5.68	0.90
4 NeedSat_Sport				–	0.49***	0.41***	0.29***	0.49***	−0.06	−0.06	5.54	0.64
5 Competence_Work					–	0.36***	0.50***	0.78***	−0.20***	−0.07	5.47	0.96
6 Relatedness_Work						–	0.41***	0.74***	−0.09	−0.16**	5.47	0.96
7 Autonomy_Work							–	0.84***	−0.04	−0.12*	4.90	1.18
8 NeedSat_Work								–	−0.13*	−0.15**	4.28	0.82
9 Anx.SelfMot									–	0.16**	1.98	0.70
10 Exercise dependence											4.07	1.15

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$. NeedSat_Sport/Work: overall score for basic need satisfaction. Anx.SelfMot: anxious self-motivation.

$p < 0.01$), need for autonomy ($r = -0.11$, $p < 0.01$), and the overall need satisfaction score ($r = -0.15$, $p < 0.01$) for work/leisure were negatively related with exercise addition. An exception was basic need for competence satisfaction which was unrelated to exercise addiction ($r = -0.07$, $p = 0.27$). In contrast, the scores of need satisfaction in sports were unrelated to exercise addiction (all r's < 0.10).

Test of the Mediation Model

In order to examine whether anxious self-motivation mediates the relationship between basic psychological need satisfaction and exercise dependence, we used Hayes (2013) PROCESS macro (Model 4) to perform a bootstrapping procedure (5000 bootstraps) and a Sobel test. We repeated this analysis separately for the three basic needs and the overall score for both life domains (sport and work/leisure) and summarized the results in **Table 2**. The indirect effects for basic need for competence satisfaction, but not for the needs for relatedness and autonomy were significant. Furthermore, the overall score of need satisfaction for the work/leisure domain was marginally significant (and most likely due to the need for competence score).

The nature of the significant mediation analyses for basic need for competence satisfaction are displayed in **Figure 1**.

TABLE 2 | Indirect effects of the mediation analyses using normal distribution (Sobel test) and bootstrapping for basic psychological need satisfaction (competence, relatedness, autonomy, overall score) in the sport and work/leisure domains as the predictors, anxious self-motivation as the mediator and exercise dependence as the dependent variable.

	Indirect effects		Sobel tests		95% CI (Bootstrap)	
	b	*seb*	*z*	*p*	*LL*	*UL*
Competence_Sport	−0.05	0.02	−2.14	0.03	−0.092	−0.009
Relatedness_Sport	0.01	0.01	0.77	0.44	−0.012	0.037
Autonomy_Sport	−0.002	0.01	−0.19	0.48	−0.029	0.024
NeedSat_Sport	−0.01	0.02	−0.87	0.38	−0.051	0.017
Competence_Work/Leisure	−0.03	0.02	−2.05	0.04	−0.073	−0.007
Relatedness_Work/Leisure	0.01	0.01	−1.29	0.20	−0.045	0.005
Autonomy_Work/Leisure	−0.01	0.01	−0.67	0.50	−0.026	0.010
NeedSat_Work/Leisure	−0.03	0.01	−1.65	0.09	−0.063	−0.001

NeedSat_Sport/Work: overall score for basic need satisfaction.

DISCUSSION

The present study supported our hypothesis and the underlying compensation hypothesis that low basic need for autonomy and social relatedness satisfaction outside the sport activity (work/leisure time) is associated with exercise addiction, whereas the same need satisfaction scores in sport are unrelated. An exception is the basic need for competence in the work/leisure domain, which was unexpectedly not directly linked to exercise addiction. Its relation to exercise addiction can only be found once anxious self-motivation is considered as a mediator. Low basic need for competence satisfaction, for example at work, makes people anxiously self-motivated. Driven by fear and the attempt to avoid further unfulfilled needs they engage excessively in behavior that promises competence experience (e.g., exercising). A set of mediation analyses might have supported our assumptions about highlighting the need for competence satisfaction (rather than relatedness or autonomy for which no significant mediation effects could be revealed). The competence satisfaction → anxious self-motivation → exercise addiction mediation also holds true for need satisfaction experienced in the activity (exercising) itself. It seems plausible that a lack of competence feelings in endurance sports motivates people to invest more effort into the activity; particularly because effort investment is usually a successful strategy in this kind of sport. However, an unhealthy type of motivation results, when anxious self-motivation lies at the heart of this attempt.

Future research is needed to address several open research questions linked to our assumptions and findings, such as whether the athletes are consciously aware that they compensate frustrated basic needs in one domain (e.g., at the work place) by engaging in alternative activities (exercising). As already stated, the compensatory approach is not limited to the need frustration-compensatory behavior pair that we analyzed in the present study. The compensatory approach could also mean that people

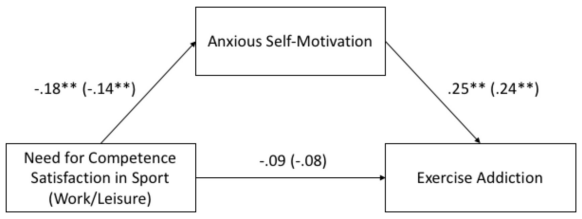

FIGURE 1 | Illustration of the significant mediation models. Need for competence satisfaction in the sport and in the work/leisure (coefficients in brackets) domain predicts exercise addiction through anxious self-motivation. $^{**}p < 0.01$.

aim to compensate their need frustration in sports with excessive work (workaholism) or with drinking alcohol (when drinking alcohol makes them feel competent). Thus, it could be of interest to evaluate other types of behavioral addictions and substance addictions as potential need compensatory activities (Taylor and Thompson, 2018). A further question could address what distinguishes individuals who respond with exercise dependence or other types of dependence from those who do not (test of a moderated mediation).

Through our research, we have added to the existing literature on exercise dependence by combining motivational and self-control antecedents as explanations for exercise dependence: Whereas previous research on exercise dependence has focussed on physiological reasons for exercise addiction, such as the release of endorphins, which are responsible for euphoric feelings during exercise (Morgan, 1985), and on learning processes such as the positive consequences of exercising (relaxation, mastery experience, goal attainment), which reward the activity and enhance the likelihood of performing it again, we have added low basic psychological need satisfaction and anxious self-motivation to the list of variables which lead to exercise dependence. As mentioned before, the present study proposes that basic psychological need of competence thwarting in other life domains may lead to excessive sport behavior especially when athletes feel afraid of further need thwarting. For this reason they might excessively participate in sports because this provides controllable satisfaction of the need for competence.

Our study also contributes to basic psychological need theory. The few studies that have linked self-determination theory with maladaptive exercise behavior, such as exercise dependence (Frederick and Ryan, 1993; Hamer et al., 2002), have focussed on the mode of self-regulation (ranging from external, introjected, identified, integrated to intrinsic regulation; see Deci and Ryan, 1985) in sport rather than assuming a compensatory mechanism, as in the present study. These studies found that introjected and identified regulation (already relatively self-determined forms of regulation) in sports are positive predictors of exercise dependence. This indicates that a strong engagement in exercise requires some degree of self-determination (Hall et al., 2007).

One study which considered the level of basic need satisfaction in addition to forms of self-control was conducted by Edmunds et al. (2005). However, the authors relate need satisfaction to exercise activity (e.g., "*I feel like I am free to decide for myself how to exercise*"; "*Most days I feel a sense of accomplishment from exercising.*"; "*People I exercise with take my feelings into consideration*") rather than to other life domains in which basic need satisfaction might be low (as we did in assuming a compensatory mechanism). They found that athletes displaying symptoms of dependence reported higher levels of need for competence (but not need for autonomy and relatedness) compared with individuals who do not exhibit symptoms of dependence. Furthermore, they displayed higher levels of identified, integrated and intrinsic motivation. This supports the above-mentioned assumption that a high level of commitment in sports, or even exercise dependence, requires a certain degree of self-determination.

It must also be pointed out here that the ultra-endurance athletes in our study score relatively high in the exercise addiction measure with a mean score right at the cut-off point (24 – 4.0 at item level, see **Table 1**). This means we could investigate the relationship between need satisfaction, avoidance motivation, and exercise dependence in a high-risk sample for whom these results are very important.

Although the present study mainly supports our hypothesis, it is important to point out that our results must be interpreted with caution due to relatively weak effects (e.g., correlations between variables were significant, but low) and a lack of replication so far. However, our approach has practical implications that differ from the implications derived from previous explanatory models. It suggests that a more profound way of addressing critical exercise behavior (than for example, by reducing the amount of exercise behavior using techniques of impulse control) would be to improve need satisfaction in other life domains and in particular basic need for competence satisfaction. If people feel competent at their workplace, for example, they will not need compensatory behavior that endangers their health. Examples of how competence satisfaction can be fostered are regular feedback and well-structured contexts, structure in the form of guidelines, rules and norms which are not experienced as being controlling. These are essential in order to feel competent and autonomous (Vansteenkiste et al., 2010, p. 123).

Another methodological limitation of the present study is that it is based on correlational data. Causal interpretations are thus not warranted. Long-term studies which examine the association between the two variables over an extended period of time (for example, from beginning with an endurance sport up to an extreme endurance sport level) could answer the question of causality more appropriately. We speculate that such a study would reveal a circular interplay between basic need satisfaction and exercise addiction in the sense that need frustration leads to exercise dependence, which in turn aggravates conflicts in one's social and professional life and further leads to low basic need satisfaction.

We would like to end this report with the statement that it is important to analyze the conditions under which sport and exercise become harmful. We fully agree with the current research trend positing that exercise is physically and

psychologically beneficial to health and that it is absolutely necessary to examine, support and create the conditions under which individuals exercise regularly. However, we would also like to suggest that it is important to analyze the conditions under which sport and exercise become harmful. Previous research and our own study results indicate that (the presence or absence of) basic psychological needs are a core concept for explaining the health-promoting initiation and maintenance of exercise behavior, as well as health-endangering excessive exercise behavior. In this regard, the present article additionally suggests that not only basic needs – described as innate psychological "nutriments" (Ryan, 1995, p. 410) – but also self-control processes (anxious self-motivation) co-determine whether or not individuals are at risk from exercise dependence.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the University of Zürich, Ethics committee of the Institute of Psychology. The protocol was approved by the Ethics committee of the Institute of Psychology. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

AUTHOR CONTRIBUTIONS

JS and BK gathered the data. JS, BK, and MW wrote the article. JS performed the statistical analyses.

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Periodization and Self-Regulation in Action Sports: Coping With the Emotional Load

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Action sports usually include some danger and personal challenge. The levels of both are often further increased when the sport is placed in a competitive environment. In this paper, we consider the Olympic disciplines of freeskiing and snowboarding in park and pipe. We consider some pertinent theoretical perspectives, then offer some insights on their operation using a range of data from ongoing research and support work. Finally, we offer a number of practical steps which can be taken to optimize performance, both in learning and practicing new tricks and in executing them under the pressures of competition.

Keywords: self-regulation, extreme sports, coaching practice, snow sports, Olympic sports

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INTRODUCTION

Extreme or action sports are frequently defined as activities where the likely outcome of a mismanaged mistake or accident is death (Brymer and Schweitzer, 2017a,b; Frühauf et al., 2017). Action sports originate from a range of sources. Some, such as rope free climbing, big wave surfing, mountaineering above 8000 m, waterfall kayaking, extreme skiing and snowboarding stem from adventure sports (Collins and Collins, 2012). Increasingly, however, others derive from more traditional sports. Interestingly, many action sports have multiple versions many of which are competitive and now organized similarly to mainstream sport while others retain their non-competitive roots. For example, surfing has an international governing body and is now a competitive sport, climbing has a competitive dimension, and both are now Olympic sports whist also retaining a non-competitive element. We suggest that freeskiing and snowboarding have a comparatively longer history of crossing the competitive/non-competitive divide that possible stems from its origins as an action sport (Ojala and Thorpe, 2015; Thorpe, 2016). In contrast, parkour, with a similar origin, acts as more recent example that is now recognized as a sport with its own governing body and regulations.

Risk is common to many action sports. When the sport moves "into the mainstream" (cf. Willmott and Collins, 2015) the challenges from risk (e.g., "will I be able to learn/complete this move safely?") are further complicated by those of competition (e.g., "will I win/do myself justice"), resulting in an increased level of psychological load for performers. The Olympic disciplines of Park and Pipe (hereafter P&P) are one such sport. Involving both skiers and snowboarders, the disciplines require participants to master and perform potentially dangerous tricks of up to four full rotations with triple twists; the current top end in this rapidly progressing sport. Indeed, these high levels of personal risk, combined with the tight social structures and ego commitment to the role of being a P&P athlete, mean that all levels face some degree of challenge.

As such, it is crucial for coaches and psychologists involved to understand and mitigate the negative impact and implications of this emotional load. Accordingly, in this paper we firstly consider some theoretical constructs which can usefully be applied to understanding and parameterizing the issue. This is followed by some exemplar data from our work in the field that help to establish how the theory applies. Finally, we present some systems and ideas which can be used to counter or control the impact on both performance and the individual.

THEORETICAL PERSPECTIVES

After careful consideration, we would highlight two major theories which apply in P&P. These are Resource Depletion Theory (RDT), as placed within work on self-control and self-regulation or SR (e.g., Vohs et al., 2012) and the almost ubiquitous if ill-defined ideas of Mental Toughness (MT; Jones et al., 2002). Other ideas are apparent but would seem of questionable applicability for the P&P environment. For example, the "adrenaline junky" idea which has led some to see action sports participants as almost addicted to the "high" of risk (e.g., Buckley, 2012; Heirene et al., 2016). As highlighted by several recent studies (e.g., Willmott and Collins, 2017), elite P&P athletes are certainly positive about the lifestyle and achievement but seem less so about the risks! Indeed, their reported perceptions of risk as a severe challenge and a factor to be controlled would otherwise seem a contradiction. Certainly, recent research attests to the variation in participant motives across extreme sports (Barlow et al., 2013) so we are comfortable staying with the RDT/MT focus.

Work on self-control and SR has shown the wide-ranging issues which can occur for individuals low in this key skill (Crockett et al., 2006; Magar et al., 2008) although almost all of this has focused on trait characteristics and chronic behavior in wide social contexts. More recently, sport studies have shown interesting, potentially causative links between SR and sporting outcome (Toering and Jordet, 2015) with the impact on practice behaviors as a potentially important mechanism (Toering et al., 2012). Even here, however, the impacts are from trait like behavior to chronic outcomes.

As a parallel development in mainstream psychology, ideas of both MT and SR as potentially transient and variable, state characteristics have emerged. With SR for example, Baumeister and colleagues offer views on the exertion of self-control which "...appears to depend on a limited resource. Just as a muscle gets tired from exertion, acts of self-control cause short-term impairments (ego depletion) in subsequent self-control, even on unrelated tasks" (Baumeister et al., 2006, p. 351). These ideas underpin RDT, which suggests a number of factors such as motivation, personal beliefs and practice as influences against "running out of" SR capacity.

In MT, originally presented solely as a trait, there has been an increasing recognition that it too can vary across situations, once again depending on the presence or absence of certain factors such as personal motivation, belief/expectation and self-efficacy (cf. Gucciardi et al., 2015). There is also a clear need to recognize when to stop trying or turn back. As identified by Crust et al. (2016), accepting one's own limits and avoiding "costly perseverance" (see also Lucas et al., 2015, p. 606) is an important feature of MT in extreme sports settings. So, for our purposes here, catering for depletion in the short term whilst building resources for the long term emerges as an important psychological focus for P&P coaches and support staff. Furthermore, since depleted self-control effects on skilled task performance have already been shown in laboratory situations (McEwan et al., 2013), this direction of study seemed justified. Before proceeding, however, we should also highlight the extent to which self-control in the present regard is more properly considered as cognitive control (Scherbaum et al., 2018). In simple terms, meeting the action sport challenge is more concerned with the direction of attention against distraction, cognitive control, than resisting temptations – self-control. Reflecting this idea, therefore, we will use SR as pertaining to the optimum direction of cognitive effort.

In addition to these psychological constructs, we should highlight one which has until now been largely used in the physiological sense; the idea of periodization. Originally developed in the former USSR in the 1960s, the idea of designing training programmes to progressively vary load toward a determined peak became a well-established and world wide feature of physical training for athletes (e.g., Bompa, 1984). The approach has undergone a number of reiterations (e.g., Issurin, 2010) but still remains fundamentally unchanged, despite an increasing questioning of the underpinning mechanisms and efficacy of the construct (e.g., Kiely, 2012). Despite these concerns, however, the basic idea of planning the distribution of training inputs to optimize outcome remains both common and indeed, one that is being extended to other elements of training and development such as tactics in team sports (e.g., Tamarit, 2015). In this paper, we suggest another new application of the periodization construct; namely, the systematic variation of emotional load and challenge to optimize the learning and execution of high risk skills.

EVIDENCE FOR HOW THESE IDEAS MAY OPERATE – EXEMPLAR DATA

If RDT is a genuine factor in P&P skill development, then performers would show development in "bursts" rather than as a steady progression. Notably, however, this pattern would not necessarily be universal, since those "better equipped" on the SR front would cope better and for longer with pressure. Therefore, to really examine for the presence and impact of SR strength, coupled with RDT, an individual focus against tricks of high perceived challenge is necessary. In general, athletes would be expected to show patterns of hard pushing interspersed with slower progress/recovery. Furthermore, from an individual perspective, the push/recover ratio would be expected to vary across athletes depending on their SR skills and mental strength.

Looking at studies of trick progression, for example, this is just what is apparent (cf. Willmott and Collins, 2017). In short, the general push/recover cycle is common across athletes whilst

individuals vary in ratio depending on mental skills. Of course, there are undoubtedly a number of other factors which contribute to the "progress in bursts" pattern which is typically apparent. Access to appropriate facilities, including airbags (in some cases) and snow (in most cases!), is just one such pragmatic issue. There are also, however, patterns of development which, we suggest, show a deliberate and carefully planned variation in mental challenge and load reflective of the general and individual factors mentioned above. In this paper we refer to this as "emotional periodization." For example, athletes getting things set up in phases so that the first attempts of a trick could be timed to meet set dates or attempted in optimum conditions. Often, athletes plan progression into pre-determined time frames in order to achieve sufficient repetition to transition a new trick to specific competitions. Typical catalytic influences being major events such as the X-Games and, more recently, the Olympics. Notably, other periodized plans see trick development focused on optimum conditions, such as the softer and more forgiving snow of a summer training camp.

Coach interviews also show an awareness of the need for periodization (Willmott, 2017, Unpublished). Coaches are very aware of the need to time when to push and when to hold off: making these decisions reliant on a good deal of knowledge about, and carefully developed awareness of, their athletes; an ability to read athletes' mood early through body language, signs of physical and emotional fatigue, verbal cues, etc. This approach is typically used together with, in many cases, developing the skills to manipulate mood through a variety of subtle and sometimes not so subtle actions, statements and approaches.

Results from athlete surveys (Willmott, 2017, Unpublished) also evidence the emotional periodization approach. Athletes highlight the high emotional effort invested in acquiring new and high-end skills in planning, preparation and execution versus the comparatively straight forward and sometimes *ad hoc* approach to refining existing simpler and/or well rehearsed skills. Of interest, plans are often made for the next day and mental preparation done, with alternatives built in depending on conditions. As one multiple medallist snowboarder stated:

> *I always go up to the mountain with a plan, right? And I think that's also key and I've seen people get hurt when they are kind of lackadaisical when they go up to the mountain, so I have a plan A and only a plan B maybe a C, right? Because halfpipes are different, weather's always different.*

The point here being that plans were built around the quanta of mental energy needed across the day. This athlete went on to stress the importance of developing then using the mental energy to best effect.

> *you wanna optimize every single day, . . ., you wanna make the most of it because you got your coach there you know already going into it mentally you're like 'This is a training camp, we gotta get ready, here's what I wanna do, let's get after it.*

Supporting this view, several athletes talked about the need to build SR strength; to "put money into the bank, then spend it carefully when it will be of most benefit."

As a final piece of evidence, we refer to one of the tracking devices developed for use with New Zealand Snowsport athletes. **Figure 1** is an example, covering a 1 month training period.

The pattern of risk shown here makes the point nicely. The athlete "builds up" to a block of high risk/high failure runs (shown in purple and yellow, respectively), takes a break, goes again at a lower level, another break then a peak block of work then a final rest followed by a "consolidation" block to embed the new tricks (cf. Carson and Collins, 2016). As such, we use the physical periodization idea against emotional loading. The figure also shows other ideas relevant for the longer term development of the athlete's skill base; for example, the need to monitor and work on all spin directions. For the present purpose, however, the periodization of effort is clear, with the athlete building up, working hard at high risk, then taking time to recover in a manner akin to classic concepts of periodization. This pattern is easily apparent when these factors are monitored. As a useful extension to the simple runs per day count provided in **Figure 1**, innovative systems to monitor physical load in P&P are being developed using inertial measuring unit devices to accurately track the number, type, direction and amount of rotations in a training session, along with cumulative landing forces along the lines of previous work in P&P using this type of technology (e.g., Harding et al., 2008; Harding and James, 2010; Scher et al., 2017). Providing useful data on physical indices of loading, other markers impacting emotional loading including "perceived risks taken" and "crashes endured," complements this data to give a more accurate holistic picture.

PRACTICAL STEPS TO COUNTER NEGATIVE INFLUENCES

Given that emotional periodization is a way in which athletes and coaches can and often do cope with the SR challenges of training and competing in P&P, what methods can be discerned and developed? Given the importance of the coach–athlete relationship (Jowett, 2017), both generally and particularly in such a high-risk domain as P&P, the power dynamic between coach and athlete is a key aspect of SR optimization.

A primary feature of data from both coach and athlete accentuates the coach's role in empowering athletes via an autonomy-supportive climate (Willmott, 2017, Unpublished; Willmott and Collins, 2017). A key part of the coach role is to help the athlete to accurately assess when to put the hammer down and when to back off. There are several facets to executing this role, including:

- A high level of trust between coach and athlete.
- Guidance from the coach on training load management (both physiological and emotional).
- Coaching awareness of fatigue, fatigue management, and smart decision-making.
- Careful weather forecasting to try to maximize and be ready/recovered for optimal conditions.
- Individual differences: some athletes need to be encouraged and given permission to progress, some athletes need to be given permission to "call it" (finish the session).

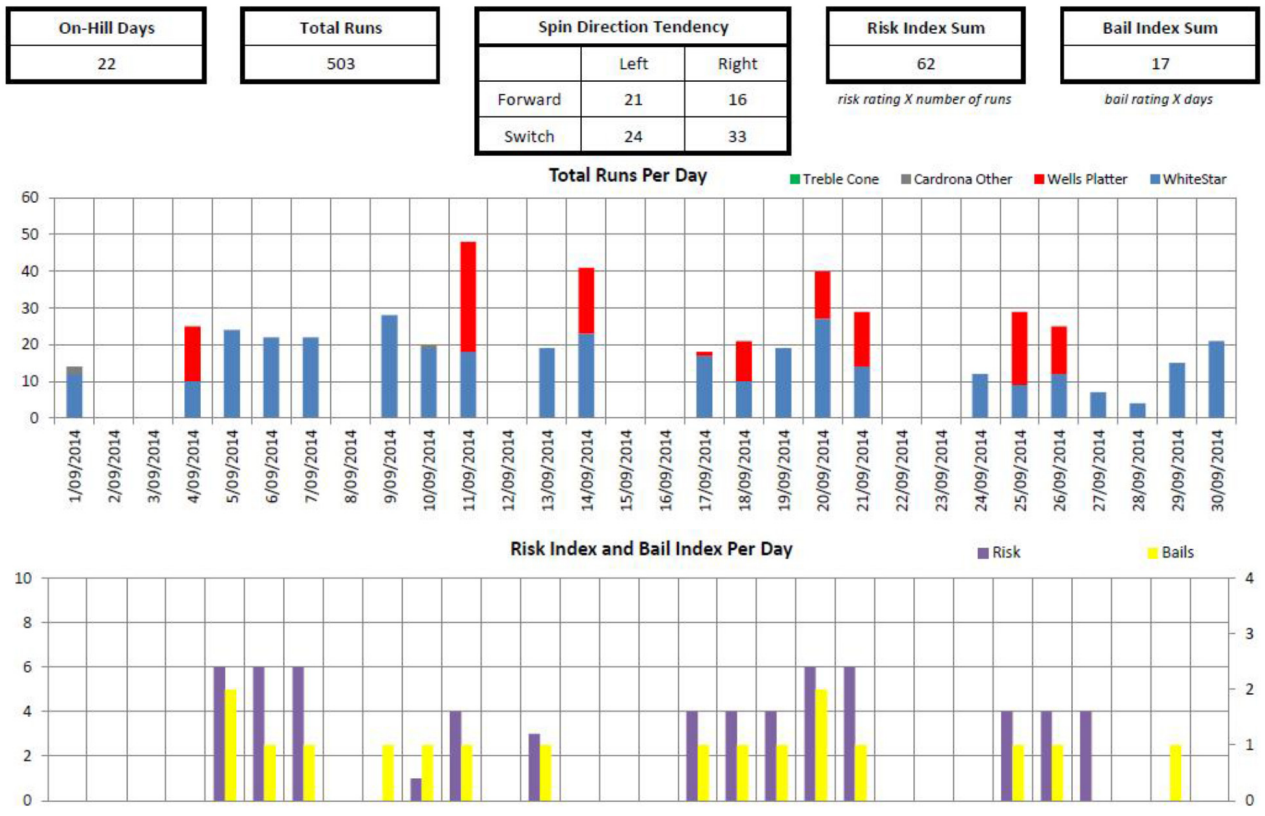

FIGURE 1 | Exemplary data on NZ Team skiers across a training phase.

- Awareness of the optimal number of repetitions of a risky maneuver to achieve learning growth while avoiding too much fatigue and injury risk.

A blend of classical combined with naturalistic decision-making is apparent in the coaching approach required; an idea developed in action sports by Collins and Collins (2014; 2015; 2016) as Professional Judgment and Decision Making or PJDM (from original work by Martindale and Collins, 2005). All three types of reflection (on-action, on-action-in-context, and in-action) as outlined by Collins and Collins, are cognitive processes in play for the coach.

The above list of elements, either individually or collectively, are reflected by the following selection of quotes from Willmott (2017, Unpublished):

I think it's important to have that trust with your coach and when I say trust it means they have to be on the same page as you. . .you have to be vocal with them, let them know how your body's feeling, um, where your mind's at.

Male Snowboard Halfpipe Athlete

I didn't realize how much working on that [new trick] took out of me, then all of a sudden it seemed to hit me, and I was struggling even to do basic stuff. So I think the best thing for me is to take two days off and then get back into it when I've recovered and I'm back on my game.

Female Freeski Halfpipe Athlete

It's a big trick and it's high risk, it's day five of the camp and while it's the last day and we really want to get it done out here, I just think there's too many red flags. [the athlete] spewed up last night with food poisoning, and he told me he was feeling pretty tired this morning, I think we should work some more into the bag, come away in one piece and come back to taking it to snow another time. What do you think?

Elite Freeski Halfpipe Coach

With more experienced and mature athletes in particular, decision-making can become a joint discussion between athlete and coach, where decisions can be audited and the appropriate outcome agreed:

So I have a confidence I'm like a little scared a little nervous obviously, but when that coach that you have that trust says 'No dude you've got this' then you're like 'OK he's telling me I got it he can see it from another set of eyes'

Male Snowboard Halfpipe Athlete

In fact, the coach can build emotional periodization into the structure of day-to-day coaching, thus making the need for variation explicit and a normal, accepted part of day-to day work. New Zealand Snowboard coach Sean Thompson has developed a "Push-Drill-Play" structure, which can be used as a daily, weekly or longer element in planning and periodization. For

example, each element can be specified in an athlete's annual plan to describe and differentiate training meso-cycles (4–8 weeks focus), at the micro-cycle level (weeks), or even in terms of a session breakdown. The same approach can be linked to the stages of learning new tricks (cf. Fitts and Posner, 1967). For example, athletes can be asked cto Push at the cognitive stage, to Drill as the skill progresses through the associative stage, then Play as the skill is automated. Further work to embed the skill is completed then returning to Push as the skill is taken to a new level of mastery through further refinement; through combinations into and out of the trick, a grab change, or incorporation in a high level competition run for the first time, for example.

A third factor is the need for athletes to focus on daily recovery mentally as well as physically. Clearly, the impacts involved in P&P can be taxing, whilst activities such as "hiking the pipe" (walking up the side if lift cycles are too long, unavailable or inappropriate) at altitude can make training a physically demanding event. Most of the time though, when generally working with gravity rather than against it, P&P athletes' energy expenditure and workload is comparatively low (e.g., Zebrowska et al., 2012). As this paper has suggested, however, the emotional challenge can be very high, especially when athletes are taking new tricks to snow for the first time. Accordingly, ensuring sufficient mental recovery is a big feature of life for these athletes. Furthermore, the dynamic nature of the stress–recovery interaction must be considered and catered for (cf. Filho et al., 2015). On a daily basis, for example, coaches and support staff should ensure time away from structured practice and other activities for athletes to decompress. "Vegging out in the hotel room" is an important element of maintaining quality on the hill, not just a mark of idleness! Importance of regular "anchor sleep" is another aspect for attention, whilst the regenerative and learning benefits of sleep are still being realized across sport (cf. Antony et al., 2012).

On a longer-term basis, facilitating engagement in other low-risk but stimulating activities for "re-creation" would be part of the planned process for any training camp. Athletes in most sports get used to living in a close proximity bubble. Getting away from the venue, and indeed each other, is just good sense. Trips for surfing, skating, into different towns or just shopping as "retail therapy" serve to maintain focus on the high-risk days planned. Finally, as a macro concern across the athlete's career, good practice would encourage life balance and other goals for distraction from the stressors of training and competition; pressures which can be characterized as living life on a knife edge.

Finally, there is a need to address the range of emotional challenges which the athlete encounters, building their skills and confidence to cope proactively (Thatcher et al., 2012) and manipulate emotions for optimum outcomes (cf. Rathschlag and Memmert, 2015). In the present context, arguably the major emotional concern is fear. Of course, fear has a dual role: on one hand it has potential to be the most debilitating emotion to performance, both directly in competition and indirectly by limiting development. On the other hand, it is crucial in terms of informing smart decision-making and keeping an athlete safe. The adrenaline junky idea has been thoroughly discredited – an athlete who feels no fear would not last long in such high-risk environments! Accordingly, one psychological strategy that is more likely to be under the Sport Psychologist's realm than the coach is the concept of rationalizing fear.

From a psychological perspective, fear has a triple effect. Firstly, it discomforts and changes the focus, making athletes more likely to dwell on and rehearse, either overtly or covertly, making mistakes. This, in turn, increases both the likelihood of occurrence and emotional challenge of attempting the trick (MacPherson et al., 2008). Some (erroneously in our view) see this inhibition as a type of Lost Move Syndrome, or the "Yips" as it is known in Golf (cf. Telegraph, 2014). Thought stopping or relaxation/mindfulness are often the prescription of choice but, since controlling fear whilst staying aware is such a core part of P&P, we would support the development of conscious cognitive control rather than avoidance (cf. Winter et al., 2014), hence our support for Rational Emotive Behavior Therapy as the approach of choice (see below).

Secondly, even if the fear doesn't actually stop the athlete executing the trick, it can disrupt the timing, placing too much emphasis on one part of the movement. In fact, this can be almost as bad, as the athlete internalizes/embeds a flawed way of doing things which is really hard to clear. Working on this early to build and embed the right rhythm and consequent feel is key here (cf. MacPherson et al., 2009). The use of "video templates," showing the athlete as self or similar-other model executing at the right pace, is a very useful coaching tool.

As the third challenge, fear exerts a chronic effect, "eating away" at the athlete as s/he struggles to control the intrusive thoughts. Similar to those experienced when returning from injury (e.g., Salim et al., 2016), this pattern can lead to a negative spiral of both acute and chronic disruption. Recognizing that it is the perception of the fear, rather than the arousal itself that is the problem (cf. Raedeke and Stein, 1994), our preferred solution has involved the use of Rational Emotive Behavior Therapy (REBT; Ellis, 1957, 2004; Turner and Barker, 2014). This active approach involves the psychologist exploring, challenging and realigning the emotional reactions of the athlete client. As such, it is perfect for addressing misconceptions or misperceptions which may have occurred but which, if left to persist, may well grow to disproportionate and dysfunctional levels.

CONCLUSION

The aim of this paper has been to consider the implications of SR; a major factor for such a mentally demanding high-risk action sport. On the basis of the data cited and discussed, we would suggest that P&P athletes could usefully be surveyed and compared to the extreme mountaineers examined by Crust et al. (2016), not least for the similarity that too much MT in action sports (especially without enough experience) can result in injury or even death through impaired decision making. Data are clearly supportive of a short term, transient and context-specific type of

MT, through which athletes make informed decisions about the acceptability of risk. This awaits further work and is highlighted as an area for further investigation.

From an applied perspective, we have listed several steps and procedures through which emotional pressures can be monitored, controlled for and addressed. The use of mental skills training as an adjunct to these ideas is another important feature of the modern P&P experience (cf. Willmott and Collins, 2015). As such, work here is paralleling but also extending in depth and range, work on psychological skills training in other challenging domains (e.g., High Intensity Sports; Birrer and Morgan, 2010). Investment in skills development is often seen as a longer term, even career long factor. In our experience, however, much can be achieved through short, intensive and challenge-specific interventions. Certainly positive changes can be affected in relevant skills with short term intense interventions (e.g., 5 days of meditation; Tang et al., 2007). The optimum use of support specialists is another topic for further investigation. For the present, however, the importance of optimizing SR and MT in P&P athletes is an important applied issue and also one with a sound theoretical grounding.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of University of Central Lancashire. The protocol was approved by the BAHSS ethics committee. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

AUTHOR CONTRIBUTIONS

DC contributed to the conception of the study initial writing and review of the manuscript and analysis. TW contributed in data collection and analysis, plus conception of study, and writing of the manuscript. LC contributed to analysis, review, and writing of the manuscript.

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Comparison of the Personality Traits of Male and Female BASE Jumpers

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BASE jumping is an extreme adventure sport which consists of jumping from a fixed object with specially adapted parachutes. A few studies of the personality of BASE jumpers have been conducted, but little is known about how the women in this sport compare to the men. The purpose of this study is to compare the personality traits among a sample of men and women who are experienced BASE jumpers, as this provides an interesting and important opportunity to better understand the motivation for extreme sports. Eighty-three participants completed the Temperament and Character Inventory the day before the jump at the New River Gorge Bridge Day BASE Jumping event, West Virginia, United States. The sample included 64 men and 19 women. Results show that men and women BASE jumpers shared similar personality traits both in terms of temperament and character, except for the character trait of cooperativeness on which women scored higher than men. This suggests that the basic drive for participation in extreme sports is self-regulation of personal emotional drives and needs for self-actualization, rather than to oppose social pressure or cultural bias against female participation. These findings are discussed in relation with other studies conducted among extreme athletes and in terms of congruence between personality and activity.

Keywords: extreme sport, BASE jumping, sex differences, temperament, character

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INTRODUCTION

BASE jumping is an extreme adventure sport which consists of jumping from a fixed object with specially adapted parachutes. "BASE" is an acronym for the four categories of fixed objects from which one can jump: Building, Antenna, Span (bridge, arch, or dome) and Earth (a cliff or other natural formation). This sport developed out of skydiving and is considered as one of the most dangerous extreme sports because of the risk of accident or death involved in the practice (Brymer, 2010; Mei-Dan et al., 2012). The injury rate estimates of 0.2–0.4% (Søreide et al., 2007; Monasterio and Mei-Dan, 2008; Mei-Dan et al., 2012) and the fatality risk estimates of 0.04% per jump (Søreide et al., 2007) and 1.7% per participant and per year (Westman and Björnstig, 2007). In addition, more than 70% of the participants report that they have witnessed the death or serious injury of another participant in the sport (Mei-Dan et al., 2012; Monasterio et al., 2012). Epidemiological data and injury reports are still scarce and may be underestimates (Mei-Dan et al., 2012; Søreide, 2012). BASE jumping is much more dangerous than skydiving (Søreide et al., 2007; Mei-Dan et al., 2012).

It is practiced at a lower altitude than skydiving, which involves less aerodynamic control and more flight instability, and BASE jumpers jump with a single canopy with no reserve parachute (Monasterio and Mei-Dan, 2008; Mei-Dan et al., 2012). Because of the high risk associated with BASE jumping, it is prohibited in most public places. BASE jumping can be considered as a highly demanding activity in terms of training, discipline, and control (Brymer, 2010). It requires the participants to learn about the sport, about the characteristics of the site where they plan to jump, about the environmental conditions, and finally about themselves (e.g., Brymer, 2010). For example, participants must develop an in-depth understanding of equipment and its use, glide and flight techniques, and environmental parameters such as the strength and direction of the wind, pressure, altitude, natural formation, etc. In addition, there are many rules to apply while jumping, such as legal policies related to the specific site, and broader ethical rules (see more details on the official BASE jumping at http://www.cawp.rutgers.edu/). They also need to acquire knowledge about their own reaction under extreme conditions in order to make the right decisions and maintain safe behavior throughout the jump.

Extreme athletes have often been described as persons who tend to search for high risk experiences involving elevated levels of sensation, physiological arousal, and novelty (Zuckerman, 1983; Freixanet, 1991; Roberti, 2004; Monasterio et al., 2012, 2014). They have also been described as self-confident and optimistic individuals who tend to attribute accidents and fatalities to internal characteristics rather than to external circumstances (Morrongiellon and Rennie, 1998; Cloninger et al., 2006; Laurendeau, 2006, 2011). Even though, it has been argued that extreme athletes and BASE jumpers were not free from fear, in particular when close to the jump or risky event, it has been shown that they tend to underestimate risks and to show an optimism bias regarding their personal risk of being injured (Martha et al., 2010).

Accordingly, personality studies have demonstrated that most BASE jumpers were both high on the temperament traits of novelty and sensation seeking and low on harm avoidance. Temperament traits refer to automatic responses to emotional stimuli whereas character traits refer to voluntary goals and values. Novelty seeking is an automatic and biased response to novelty which is moderately heritable and which is reflected by impulsive decision making, active avoidance of frustration, extravagance in approach to cues of reward, and quick loss of temper. Whereas novelty seeking is a heritable bias in the activation of behaviors, harm avoidance is a heritable bias in the inhibition or cessation of behaviors and it is reflected through pessimistic worry, passive avoidance behaviors, shyness with strangers, and fatigability (Cloninger et al., 1993). Consequently, a combination of both high novelty seeking and low harm avoidance predicts impulsive, extraverted, and disinhibited behaviors (Cloninger, 2004). Accordingly, high-risk activity might be a way to regulate affects for those persons who score high on novelty seeking and who are not restrained by harm avoidance (Castanier et al., 2010a).

In addition, extreme athletes may also pursue higher-level motives, such as goal achievement, mastery-seeking, social motivation, connection with the natural environment, feeling of pleasurable bodily sensations, achievement of unselfconsciousness (Brymer, 2010; Buckley, 2012; Kerr and Mackenzie, 2012). As an example, Holmbom et al. (2017) conceived proximity flying as a transformative experience that changes one's perspective on life, one's skills and sense of identity. In terms of character, BASE jumpers often are highly self-directed and mature individuals who score highly on self-directedness and cooperativeness scales though they have extreme scores on temperament scales (Monasterio et al., 2012, 2016). Put another way, strong character traits allow the self-regulation of extreme temperament traits, which is crucial to minimize the risks of BASE jumping. Such findings are interesting because it has been shown that even if temperament (i.e., measured by novelty seeking, harm avoidance, reward dependence, and persistence) constrains character development (i.e., measured by self-directedness, cooperativeness, and self-transcendence) (Cloninger et al., 1997), character development is more predictive of health and well-being than temperament (Cloninger et al., 1997; Josefsson et al., 2011). Hence, people with similar temperament profiles, which correspond to emotional drives and automatic behavioral responses, can behave in distinct ways and can be either healthy, happy, and well-integrated in society; or with poor health, psychopathological features, and maladaptation to the society, depending on the development of their character (Cloninger and Zohar, 2010). Accordingly, the conscious goal BASE jumpers pursue by acting in a certain way will be reflected by their character development rather than by their temperament profile, even though their behaviors may also be driven by impulses and emotions which are reflected by high scores on temperament traits.

However, studies conducted among BASE jumpers and other extreme sports usually don't consider gender differences and little is known about female participants of extreme sport. As a matter of fact, women are even sometimes excluded from the studies on high-risk sports because of their low frequency (Castanier et al., 2010a,b; Martha et al., 2010). 90% of BASE jumpers are actually males (Søreide et al., 2007), and men represent about 81 to 92% of cases of injuries and fatalities (Westman and Björnstig, 2007; Mei-Dan et al., 2012; Søreide, 2012; Mei-Dan et al., 2013). Published results usually aggregate subjects regardless of gender, so it is uncertain how similar the minority of women are to the men in these samples.

The differences of prevalence between men and women in extreme sports are not really surprising. On the one hand, women have for a long time been less involved than men in sport and extreme sports because of culture and gender roles (Lopiano, 2000; Gieseler, 2012). On the other hand, studies on personality in samples representative of the general population have found that women tend to score slightly lower than men on the temperament dimensions of novelty seeking or sensation seeking and slightly higher than men on harm avoidance. They also score substantially higher on reward dependence and cooperativeness, and slightly higher in self-transcendence traits (Cloninger et al., 1993; Feingold, 1994; Miettunen et al., 2007; Fresán et al., 2011; Del Giudice et al., 2012; Cross et al., 2013; Josefsson et al., 2013).

The gender difference in the prevalence of BASE jumping provides an interesting and important opportunity to better understand the motivation for extreme sports, as has been considered for personality disorders and alcohol use disorders in other work (Cloninger et al., 1978). What is the basic motive that drives men and/or women to take the risks involved in extreme sports despite cultural obstacles? If the motivation is to oppose cultural norms, women would need to differ more extremely than men because the cultural opposition is greater to the participation of women, as is the case for gender differences in antisocial personality disorder (Cloninger et al., 1978). On the other hand, if the motivation is self-regulation of personal drives and needs for self-actualization, the genders would not be expected to differ because the strength or weakness of the predisposition for self-regulation has an internal locus of control unrelated to cultural opposition, as is the case for gender differences in alcohol use disorders (Cloninger et al., 1978).

Gender differences is a field of widespread interest in which the differences have been viewed from several perspectives, including evolution (Davies and Shackelford, 2006), biology, and sociology or culture (see for example Lyng, 1990; Feingold, 1994). As a matter of fact, while briefly retracing the history of risk-taking activity and extreme sports, Søreide (2012) found that such activity was used as a test of male courage and as a passage into manhood. In the same range of ideas, Lyng defines voluntary risk-taking in terms of negotiating with the "edge" which is the boundary between life and death, consciousness and unconsciousness, or the idea of testing the limits of body and mind (1990). He also describes edgework experience in terms of a search for self-determination, self-actualization and self-realization, which comes along with a specific sequence of emotions, and with an alteration in perceptions and consciousness (1990). In turn, risk-taking activity and sport in general had been considered as harmful for women's health and for their reproductive health in particular (Lopiano, 2000; United Nation's report on women, gender, equality and sport, 2007).

From an evolutionary perspective, differences between men and women have been explained in terms of sexuality and natural selection (Davies and Shackelford, 2006; Del Giudice et al., 2012). For instance, risk taking has been considered as a product of differential adaptive challenges among men and women (Davies and Shackelford, 2006). Such a view is argued to be complementary with the biosocial theory which addresses sex differences in terms of biological differences (e.g., anatomical attributes, hormones, rhythms, or cycles) and of contextual factors (i.e., social, economic, technological, and ecological forces) (Davies and Shackelford, 2006). According to the sociological perspective, gender differences result from societal norms regarding social roles and from the conformity with other's expectancies which are often driven by stereotypical beliefs (i.e., social role model and expectancy model). Differences observed are also sometimes reduced to an artifact in the measurement, due to social desirability (Feingold, 1994).

Although there may have been different pressures shaping the personalities and biology of men and women over evolutionary time, the roles of women and men in society are much more similar now. As a result, women now have the same access to extreme sports that men do. Some laws such as the federal antidiscrimination law (title IX in 1972 in the United States) and the Amateur Sports Act of 1978 have contributed to open access to women in sport. Those laws came along with the recognition of sport benefits in terms of physical, mental, social, and spiritual health of women (Lopiano, 2000). For example, sport practice has been associated with an increase in confidence, self-esteem, academic success and a decrease in the initiation of high-risk health behaviors among women (Lopiano, 2000 for a brief review). As a consequence, women's participation in sport has increased within the last few decades. For example, 17.8% of high school athletes were women in 1972 in the United States whereas they were 40% in 1996 (Lopiano, 2000). Similar trends have been observed among college and Olympics' athletes (Lopiano, 2000). It is thus possible that the sociological context have allowed the expression of women's drives and interest through sport. In a study conducted among male and female athletes (hockey players and figure skaters), Wiley and colleagues found for example that men and women had similar levels of overall involvement in sport. Women had a higher level of attraction to sport than men did, whereas men considered sport as more central in their life than women did (Wiley et al., 2000). In addition, Hardin and Greer (2009) found that action sports were considered both by men and women as a masculine sport, but also as a category of sport apart from what they named "hyper-masculine sports" (i.e., football, weightlifting, rugby, basketball), "neutral sports" (i.e., soccer, swimming, tennis), and "feminine sports" (volleyball, gymnastics). In fact, extreme sports such as BASE jumping don't imply body contact and don't require important physical strengths which are usually associated with masculine sports (Metheny, 1967; Wiley et al., 2000). Finally, even if women tend to score lower than men on novelty seeking and higher on harm avoidance on average, all kinds of personality profiles exists among both women and men. Thus, people sharing the same traits or personality profiles, regardless of their gender, are more likely to share similar drives, cognitions and to choose similar activities. In fact, previous studies have shown that people tend to choose activities that are congruent with their personality (Courneya and Hellsten, 1998; Sievert et al., 2016). Personality also predicts the individual motives to exercising (Ingledew and Markland, 2008) and has been shown to be a better predictor of motivations to exercise than gender was (Davis et al., 1995). It would not be surprising then to find that women have similar personality profiles than men among BASE jumpers.

Still, little is known about female BASE jumpers or other populations of extreme sportswomen. Interestingly, available studies have shown that women who are experienced in extreme sports may be similar to the men (Cazenave et al., 2007; Modroño and Guillen, 2011). For example, in their study among 79 high-level windsurfers, Modroño and Guillen (2011) found that women scored similarly to men on anxiety and self-confidence scales. Modroño and Guillén (2016) observed again that men and women windsurfers didn't differ in terms of sport motivation, goal orientation, or physical self-concept. Cazenave et al. (2007) studied the purpose of the risky activity and found that women who were engaged in risk-taking sports for leisure purpose had a more "masculine" profile than women

who were engaged in high-risk activities for professional purpose. Masculinity was here defined as a high level of leadership, sportsmanship, self-confidence, and a low level of consideration for others and tenderness (Bem, 1974). In other words, women whose profession involved risk-taking were described as having less masculine traits and more feminine ones in comparison to women engaged in high-risk activities for leisure purpose. Women who practiced their activity for a leisure purpose were also more impulsive and sensation seekers in comparison to women pursuing a professional purpose. Women at leisure more often used an escape from awareness strategy to regulate distress (i.e., turning attention away from the self or engaging in actions that reduce the level of self-awareness) and they used less often a compensation strategy (i.e., shifting emphasis from less rewarding self-definitions to more rewarding ones). This subgroup finally included more alexithymic individuals than the other one.

However, very few studies have investigated such gender differences among extreme athletes using a comprehensive model of personality, and, to our knowledge, no study comparing men and women have been conducted among BASE jumpers. The purpose of the study is to compare men and women who are experienced BASE jumpers using the Temperament and Character Inventory (TCI), a comprehensive model of personality.

Temperament and Character Inventory (TCI)

The TCI is an inventory for personality traits for Cloninger's psychobiological model of personality (Cloninger et al., 1993), which explains personality in terms of complex adaptive systems interacting with each other. Personality has been defined as "the dynamic organization within an individual of the psychobiological systems that modulate adaptation to a changing environment" (Cloninger et al., 1993) and also as "the way that people learn from experience and adapt their feelings, thoughts, and actions" (Cloninger et al., 1997). Such definition of personality includes systems regulating cognition, emotion, personal impulse control and social relations (Cloninger et al., 1997), and has been found to be the result of both heredity (i.e., genetics) and social environment and education (Cloninger et al., 1993). More precisely, the temperament has been defined in terms of automatic, preconceptual responses that are partially heritable and stable throughout life, and consists of four dimensions, namely, novelty seeking, harm avoidance, reward dependence, and persistence. Those temperament traits explain how persons respond to novelty, danger or punishment, and reward. *Novelty seeking* is viewed as a heritable bias in the activation or initiation of behaviors in response to novelty (e.g., impulsive decision making, exploratory activity); *Harm avoidance* is viewed as a heritable bias in the inhibition or cessation of behaviors (e.g., pessimistic worry, fear of uncertainty); *Reward dependence* is viewed as a heritable bias in the maintenance or continuation of ongoing behaviors (e.g., social attachment, dependence on approval of others); and *Persistence* corresponds to perseverance despite frustration and fatigue.

In contrast to temperament, character involves the conceptual organization of perceptions which influences behavioral goals and expectancies. Character expression is determined by our concepts of our identity as an autonomous individual, as a part of humanity and society, and as a part of the universe as a whole. One character dimension is *Self-directedness* which refers to the ability of an individual to control, regulate and adapt behavior to fit the situation in accordance with individually chosen goals and values, and which encompasses traits such as purposefulness, responsibility. *Cooperativeness* refers to the identification with and acceptance of other people and is related to agreeability, empathy, helpfulness to others without selfish domination. *Self-transcendence* is viewed as the identification with everything conceived as essential and consequential parts of a unified whole. It corresponds to a unitive perspective or consciousness where the person is simply aware of being part of a greater whole, and it can be described as acceptance, identification, or spiritual union with nature and its source (Cloninger et al., 1993, 1997).

In two previous studies among BASE jumpers, Monasterio et al. (2012, 2016) have studied personality using the TCI. In a first study among BASE jumpers in Monasterio et al. (2012) found that BASE jumpers scored higher than a control group on the temperament dimension of novelty seeking and lower on harm avoidance, which is consistent with results obtained in studies on sensation seeking and with studies emphasizing fear management. They also scored lower on reward dependence, which is a measure of social attachment and sentimentality. Furthermore, BASE jumpers scored higher on the character dimension of self-directedness, which is in line with previous discussions on goal achievement and self-realization. They finally scored lower on self-transcendence than the control group, which might be explained by the strong need for self-control involved in the practice. More recently, Monasterio et al. (2016) replicated the earlier results among a sample of BASE jumpers recruited at the New River Gorge Bridge Day BASE jumping event (except for the dimension of cooperativeness, which was here higher among BASE jumpers than in the control group) and identified several main multidimensional profiles in terms of temperament, character, and plasticity (for further details, see Monasterio et al., 2016). Taken together, those results suggest that not all BASE jumpers share the same personality profile or are driven by the same goals, even though most of the participants appear to share some common traits such as high novelty seeking, low harm avoidance, high self-directedness, and high cooperativeness.

This study assessed the personality of women BASE jumpers and compared this to their male counter parts.

MATERIALS AND METHODS

Participants

One-hundred and sixty-two participants from different countries at two distinct Bridge Day events volunteered to participate in the study. All participants gave a written informed consent before completing the questionnaires. Data were collected from

the 2008 ($n = 62$) and the 2014 ($n = 100$) Bridge Day events. Unique identifying codes, based on name initials and dates of birth were utilized to ensure participant data was not collected twice in 2008 and 2014. The overall number of participants at each event was around 400 participants. Participants were excluded from the study because of missing data on the TCI and 24 participants because of missing data on previous experience in BASE jumping (i.e., number of jumps and experience in years). Participants who had done less than 10 jumps prior to the event were excluded from the study ($n = 46$) in order to consider only regular BASE jumpers. The final sample was comprised of 83 participants, including 64 men (77%) and 19 women (23%) (see **Table 1**). The participants were between 20 and 79 years old ($M = 36.78$, $SD = 11.91$) and women were slightly older than men ($M = 38.53$, $SD = 11.6$ and $M = 36.27$, $SD = 12.04$, respectively). Most of the participants came from the United States and some others came from United Kingdom, Canada, Israel, and South Africa. In average, participants had been practicing BASE jumping for 6.7 years (6.1 [$SD = 5.5$] for men and 8.2 [$SD = 7.7$] for women) and the average number of jumps among participants was 132 ($SD = 302.7$). Men had experienced many more jumps than women in general ($M = 159.0$ [$SD = 340$] for men and $M = 43.5$ [$SD = 43$] for women).

Material

Participants provided demographical information and BASE jump information. They reported their number of BASE jumps per year and how long they had been involved in the sport.

They also completed the TCI (Cloninger et al., 1993). The TCI is composed of 240 true-false items that allows for the assessment of seven dimensions of personality and has already demonstrated strong internal consistency and test–rest reliability of its scales ($r = 0.8$ to 0.9) (Cloninger et al., 1994; Grucza and Goldberg, 2007).

TABLE 1 | Demographics.

	Men	Women	Total
N	64	19	83
Age			
Mean	36.3	38.5	36.8
Standard deviation	12.0	11.6	11.9
Minimum	20	25	20
Maximum	79	64	79
Time BASE jumping (years)			
Mean	6.1	8.2	6.7
Standard deviation	5.5	7.7	6.1
Minimum	0.1	1	0.1
Maximum	20	28	28
Total No. of jumps			
Mean	159.0	43.5	132.5
Standard deviation	340.0	43.2	302.7
Minimum	10	10	10
Maximum	2300	200	2300

Procedure

Data for the study was collected from the New River Gorge Bridge Day BASE Jumping event, both in 2008 and 2014. This is an annual event in October in Fayetteville, WV, United States where participants jump from a bridge 876 feet above the New River. The researchers discussed the nature and purpose of the study at this event and invited voluntary participation from attendees. Participants completed several paper questionnaires the day before the jump without remuneration, as described in prior work (Monasterio et al., 2012). The participants and conditions at the two events were comparable with no suggestion of heterogeneity. IRB approval was obtained prior to commencement of each study (Monasterio et al., 2012, 2016).

Statistical Analysis

Statistical analyses were carried out using SPSS for Windows, version 22.0. The Wilcoxon Mann–Whitney test was used as a non-parametric test for independent samples to compare the two samples of men and women because samples were small when divided by gender, and scores were not normally distributed.

RESULTS

Data collected in 2008 and in 2014 were combined in all analyses.

Mean Values

BASE jumpers in this study scored above average on Novelty Seeking, Self-Directedness and Cooperativeness, and below average on Harm Avoidance, Reward Dependence and Self-Transcendence (**Table 2**).

Gender Differences

Means and standard deviations of the seven temperament and character dimensions of the TCI for both men and women are shown in **Tables 3**, **4**.

Results showed that men and women had similar scores on all of the TCI dimensions, except for the trait of cooperativeness where women scored higher than men ($z = 1.97$, $p < 0.05$; **Figure 1**).

TABLE 2 | Distribution of the scores on the TCI scales among for all the participants ($n = 83$).

	NS	HA	RD	P	SD	C	ST
Mean	22.57	8.5	13.9	5.9	33.8	34.8	14.2
Median	22.00	7.00	15.00	6.00	35.00	36.00	13.00
Mode	18.0	4.0	15.0	5.0	40.0	40.0	20.0
Standard deviation	5.9	6.2	4.2	1.4	6.9	5.7	7.2
Variance	35.3	39.1	17.5	2.1	47.8	32.6	51.3
Minimum	12.0	.0	3.0	2.0	8.0	11.0	2.0
Maximum	35.0	26.0	23.0	8.0	43.0	41.0	31.0

NS, novelty seeking; HA, harm avoidance; RD, reward dependence; P, persistence; SD, self-directedness; C, cooperativeness; ST, self-transcendence.

TABLE 3 | Descriptive data of men and women scores on the TCI.

	NS	HA	RD	P	SD	C	ST
Mean							
Men	22.7	8.1	13.7	6.0	33.7	34.1	13.6
Women	22.2	9.8	14.9	5.7	34.2	37.3	16.1
Standard deviation							
Men	6.0	6.4	4.4	1.4	7.2	6.2	6.8
Women	5.8	5.6	3.3	1.6	6.0	2.4	8.2
Minimum							
Men	12.0	0	3.0	2.0	8.0	11.0	2.0
Women	15.0	2.0	8.0	3.0	24.0	32.0	2.0
Maximum							
Men	35.0	26.0	23.0	8.0	43.0	41.0	29.0
Women	35.0	22.0	20.0	8.0	43.0	41.0	31.0

NS, novelty seeking; HA, harm avoidance; RD, reward dependence; P, persistence; SD, self-directedness; C, cooperativeness; ST, self-transcendence.

DISCUSSION

The purpose of this study was to assess the personality of women BASE jumpers and identify possible differences in temperament and character traits when compared to their more prevalent male counterparts. We hypothesized that women would need to differ more extremely than men if their motivation is to oppose cultural biases for women to participate in extreme sports. Alternatively, we hypothesized that the genders would not differ if their motivation is satisfaction of personal drives and needs for self-actualization. Our results show that female BASE jumpers differ little in personality from male BASE jumpers, so we conclude that the basic drive for participation in extreme sports is self-actualization of personal emotional drives and needs, rather than cultural opposition. In fact, the only significant difference found in this study was on the trait of cooperativeness which is defined as being tolerant with others, agreeable, empathetic, helpful, and compassionate. Other studies have consistently shown that women in the general population score higher than men on the dimension of cooperativeness (e.g., Cloninger et al., 1993; Feingold, 1994; Fresán et al., 2011; Josefsson et al., 2013), and we find that female BASE jumpers also retain this difference from their male counterparts.

Without prospective follow-up of subjects as they continue to participate in BASE jumping, we cannot say with certainty whether some subgroups of participants change in personality as they increase in experience and self-confidence. However, we previously found that personality was associated directly with stress reactivity and with jumping history, but jumping history did not influence stress reactivity once personality was taken into account (Monasterio et al., 2016). The current findings suggest that prior personality (particularly, internal motivation for self-regulation) is the basic motivation to participate in BASE jumping, not an effort to oppose external opposition.

Our results are in line with other studies of gender differences in extreme sports. For example, in their study among windsurfers,

TABLE 4 | Independent sample tests on the TCI, depending on sex.

	NS	HA	RD	P	SD	C	ST	Jumps	Years
Mann–Whitney *U*	569	476.5	512.0	550.5	601	426.5	505	413.5	499.5
Wilcoxon W	759	2556.5	2592	740.5	791	2506.5	2585	603.5	2579.5
Z	−0.42	−1.43	−1.0	−0.64	−0.08	**−1.97***	−1.12	**−2.11***	−1.18

*(a) Grouping Variable: sex. NS, novelty seeking; HA, harm avoidance; RD, reward dependence; P, persistence; SD, self-directedness; C, cooperativeness; ST, self-transcendence. *$p < 0.05$.*

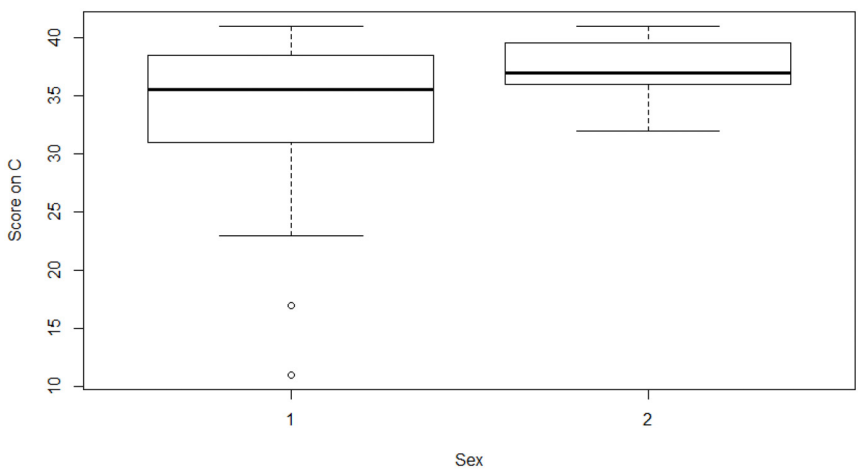

FIGURE 1 | Box plots of the distribution of men and women BASE jumpers' scores on cooperativeness. In each box, the central line is the median, the edges of the box are the 25^{th} and the 75^{th} percentiles, and the whiskers extend to the most extreme data points. All data was included in the analyses. 1 = Men; 2 = Women.

Modroño and Guillen (2011) found that men and women were not different on their level of anxiety and self-confidence. In 2016 they found that this population had a high level of self-determined motivation, a positive physical self-concept, a strong task motivational orientation and a weak ego goal orientation. Again, no significant gender differences emerged (Modroño and Guillén, 2016).

What characterizes "femininity" has been defined and measured in term of consideration for others and tenderness while "masculinity" has been defined as a high level of leadership, sportsmanship, self-confidence, and a low level of consideration for others and tenderness (Bem, 1974; Holt and Ellis, 1998; Prentice and Carranza, 2002). However, women also generally score substantially higher on reward dependence and slightly higher than men on harm avoidance and self-transcendence (Cloninger et al., 1993; Feingold, 1994; Miettunen et al., 2007; Fresán et al., 2011; Del Giudice et al., 2012; Cross et al., 2013; Josefsson et al., 2013). Such differences are not observed in our sample of BASE jumpers, except for the trait of cooperativeness.

In addition, the degree of assertiveness or self-confidence, which is sometimes considered as masculine (Bem, 1974; Holt and Ellis, 1998; Prentice and Carranza, 2002), is not differentially expressed among men and women in our study where the level of self-directedness is similar among both sexes. Self-directedness has been defined as the ability of an individual to control, regulate, and adapt behavior to fit the situation in accordance with individually chosen goals and values (Cloninger et al., 1993). In fact, this trait has been shown to be among the strongest predictor of well-being and ill-being within the personality, along with cooperativeness and self-transcendence (Cloninger et al., 2010; Josefsson et al., 2011) regardless of gender. In addition, previous studies didn't find any significant differences between men and women on self-directedness scores (Cloninger et al., 1993; Fresán et al., 2011; Josefsson et al., 2013). In other words, it seems that both men and women have this potential for self-directedness and cooperation, which are particularly elevated in the population of BASE jumpers (Monasterio et al., 2016). Both male and female BASE jumpers are usually higher in Novelty Seeking and lower in Harm Avoidance than the average of people in the general population. Considered together, personality characteristics of women and men BASE jumpers fit with the characteristics of the activity, the skills it requires, and also the kind of experience it offers. Extreme activity such as BASE jumping requires a high level of organization and self-directedness, as well as high self-control capacities along with a low level of fear when close to jump. This finding finally sustains other studies showing that men and women both tend to choose activities that are congruent with their personality (Courneya and Hellsten, 1998; Sievert et al., 2016). However, the fact that men and women BASE jumpers share common personality traits doesn't mean that they are all alike. A previous study conducted among BASE jumpers has shown that there were several personality profiles among BASE jumpers, which are defined by the interaction between several personality traits (Monasterio et al., 2016). Further studies could explore the extent to which those personality profiles are similarly distributed or not among men and women.

Application of the Findings

BASE jumping is a high risk sport with elevated rates of injuries and death (Søreide et al., 2007; Monasterio and Mei-Dan, 2008; Mei-Dan et al., 2012). The results of this study provide information on the population of women BASE jumpers, and thus may serve in the implementation of prevention and treatment plans. Understanding biases to learning and decision making based on the findings of personality traits can guide in developing adequate mental preparation for participation in high-risk activities. For example, findings of low Harm Avoidance particularly in combination with high Novelty Seeking suggests that BASE jumpers have a tendency to be optimistic and energetic in situations of danger and uncertainty, which may lead to excessive optimism in marginal conditions. Awareness of this bias and its effect on decision making at an individual level may influence toward more conservative approaches in these conditions, which may decrease the risk for adverse outcomes. It also contributes to the understanding of BASE jumpers and extreme athletes and to the body of literature on congruence between personality and activity choice.

Limitations

The present study has some limitations. First, even combining data from two BASE jumping events, the sample size of regular female participants remains small. Only 19 women participants have been included in the study. The fact that the study included more men than women is quite representative of the repartition of men and women in BASE jumping, however 19 women participants remain a small sample size. Second, the population was not a random sample and only participants who volunteered to participate in the study completed the questionnaires. Finally, we chose to study only personality traits of the participants in this first study of sex differences among BASE jumpers. However, it has already been demonstrated that personality is a complex adaptive system which contains dimensions interacting with each other. In other words, personality can't be reduced to the sum of individual traits but is rather defined as the expression of complex interactions between those traits, which is best measured as a multidimensional profile. Previous studies have found that not all BASE jumpers shared the same personality profile despite common traits (Monasterio et al., 2012, 2016). Further studies could investigate sex differences among a larger sample of BASE jumpers. A larger sample of participants would allow for the consideration of personality profiles in addition to personality traits, as it has been done in other works (Giakoumaki et al., 2016; Monasterio et al., 2016).

CONCLUSION

This study is the first study assessing sex differences among BASE jumpers using a comprehensive model of personality. Results showed that within this population, women and men shared similar personality traits including both temperament and character, except for the character trait of cooperativeness in which women scored higher than men. At least among experienced BASE jumpers, men and women do not differ much

in personality except that female BASE jumpers retain the general advantage of women being more cooperative than men. Such results indicate that the demands of BASE jumping result in comparable personality traits regardless of gender. Regardless of gender, BASE jumpers must have what Tom Wolfe called the "Right Stuff" (Monasterio et al., 2016) – willingness to take risks combined with the responsibility to discipline one's self to minimize those risks. Nonetheless, further research on larger sample of female extreme athletes would allow further exploration of the heterogeneity of personality profiles within both male and female extreme athletes.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the following guidelines (IRB# 14-1942; approved 9/4/2014). Institutional Review Board approval was obtained prior to commencement of the study from the University of North Carolina at Chapel Hill Written consent was obtained from those who agreed to participate in the survey in accordance with the stipulated IRB procedure and in accordance with the Declaration of Helsinki.

AUTHOR CONTRIBUTIONS

EM and RC contributed to analysis and interpretation of data. AH, EM, and OM-D to data collection. All the authors to review and approval of the final manuscript.

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Why Do You Ride?: A Characterization of Mountain Bikers, Their Engagement Methods, and Perceived Links to Mental Health and Well-Being

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Mountain biking is an increasingly popular outdoor activity on the extreme sport continuum. Extreme and high-risk sports have been investigated using a variety of motivational theories with sensation seeking a dominant theme; however, behavioral and motivational homogeneity within these types of populations should not be assumed. Recent studies have highlighted the therapeutic potential of extreme sports and similar outdoor activities. The aim of this study was to describe the characteristics of mountain biking participants, their engagement methods, and perceived benefits to mental health and well-being. This was a cross-sectional survey and participants were recruited via social media. An online questionnaire specific to the domain of mountain biking was developed. Analysis of the full sample (n = 1,484) and of three independent paired sub-samples was conducted using SPSS. The sub-samples compared the results of males and females; younger and older riders; and those who have recently engaged in downhill mountain biking and those who have not. The results have succeeded in identifying some disparities in mountain biker characteristics and engagement methods. The results suggest that some riders found pleasure in higher risk engagement. The study proposes various explanations for the disproportion of women in mountain biking. Irrespective of the confounding factors related to rider characteristics or engagement methods, mountain bikers reported copious benefits to mental health and well-being related to their engagement. There was a high reported usage of mountain biking as a coping strategy. As such, this study provides insights that could inform the development of outdoor activities as interventions for mental health.

Keywords: mountain biking, mental health, extreme sports, outdoor activities, nature, health promotion, well-being

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INTRODUCTION

Extreme sports are described as activities where a mismanaged mistake or accident would most likely result in death (Brymer, 2005). However, activities that bear little resemblance to one another, requiring different levels of commitment and skill (such as rope-free climbing and bungee jumping), have been described as *extreme sports* (Brymer, 2010). Single activities are also regularly

deemed to be extreme across the board, irrespective of the myriad possible ways to participate. A primary consequence is that variability in motivational orientation of participants of extreme sports, and participants' methods of engagement, have largely been overlooked (Jones et al., 2015; Clough et al., 2016; Zajc and Berzelak, 2016).

Mountain biking is a modern activity consisting of various off-road cycling disciplines. Participation varies from cycling on bridleways and canal towpaths, to more hazardous and challenging riding on extreme terrain. The International Mountain Biking Association (IMBA) estimated that the yearly participation figures for mountain biking in the United Kingdom was ∼5 million in 2005 (Corporate Research Associates, 2010, p. 41); having grown considerably in popularity over the last 30 years (Moularde and Weaver, 2016; Poulson, 2016). Mountain biking has been given an assortment of labels; for example: a lifestyle sport (McCormack, 2017); a serious-leisure activity "on the hard-soft adventure continuum" (Taylor, 2010, p. 270); and an action and adventure sport (Immonen et al., 2017). Downhill mountain biking has been defined as an extreme sport (Becker et al., 2013) and an extreme sport subculture (Hagen, 2013). Becker and Moroder (2017) argue that all forms of off-road biking done in mountainous regions should be considered "extreme" (p. 149). Recent evidence regarding the morbidity associated with mountain biking suggested that it carries a "significant risk of life-threatening injury across all levels of participation" (Jeys et al., 2001, p. 197). Within this study mountain biking is considered *an activity on the extreme sports continuum*.

Historically, psychological research into extreme and adventure sports has largely been concerned with sensation-seeking, impulsivity and risk-taking behavior (Brymer and Schweitzer, 2017). The emphasis on risk has led to participation in extreme sports often being understood, until recently, as little more than thrill-seeking, deviant behavior (Zuckerman, 2000) carried out by "adrenaline-junkies." The popular mountain bike media has also tended to over-emphasize the danger perceived in the sport, often portraying an ideology of hegemonic masculinity (Poulson, 2016). A survey found that 60.6% ($n = 436$) of females believed that the perception of mountain biking as "hard-core" was deterring women from participating (International Mountain Biking Association, 2010).

Recent research is more aligned to the lived experience of participants. Participation in high-risk activities does not necessarily equate to overestimation of abilities, or impulsive, irresponsible behavior (Llewellyn et al., 2008; Brymer, 2010). Rather, it is argued that hazards are usually mediated by the participant through a process of building competence and skill through experience; as opposed to taking risks for risk's sake (Llewellyn and Sanchez, 2008; Taylor, 2010; Lynch and Dibben, 2016; Frühauf et al., 2017). Participants may still experience fear as they test their mental and physical capabilities in challenging situations (Dodson, 1996; Lyng, 2005); but the fear could be understood as a sign that one is "pushing up against limitations and breaking throughboundaries" (Willig, 2008, p. 696), as opposed to recklessness. Contemporary literature has also included studies on the meaningfulness of extreme sports and links to psychological well-being (e.g., Willig, 2008; Brymer and Oades, 2009; Taylor, 2010; Cycling UK, 2017; Immonen et al., 2017). Evidence is also building to suggest that mainstream interventions for mental health should include extreme and adventure sports (Clough et al., 2016).

Recent mountain biking research also challenges the traditional perspective. Findings propose that regular off-road riders "generally do not fit the stereotype of mountain bikers as adrenaline-junkies" (Cycling UK, 2017, p. 7). Thrill-seeking should not be ignored - indeed, mountain biking participants have indicated that speed and adrenaline can be a motivation for participation (International Mountain Biking Association, 2010). There is also evidence to suggest that thrill-seeking may play a bigger part in initial motivation to engage in such activities, but that a desire to master skills and maintain health and well-being soon becomes more dominant (Willig, 2008; Cycling UK, 2017). Evidence is building to suggest that mountain biking participants are also motivated by intense positive emotions and fulfilling experiences (Dodson, 1996); challenge; opportunities for self-responsibility; development of identity; the aesthetics of the natural environment (Lynch and Dibben, 2016; Moularde and Weaver, 2016).

Mental health problems are a growing public health concern. Depression is now the leading cause of disability and ill health worldwide, increasing the risk of substance misuse and suicide (World Health Organization, 2018). The evidence supporting positive physical and psychosocial health outcomes in relation to nature-based activities and experiences is substantial (Brymer et al., 2010; Ryan et al., 2010; Scheinfeld et al., 2011; Mitchell, 2013; Martyn and Brymer, 2016; Yeh et al., 2016; Lawton et al., 2017). The natural environment is an integral part of the mountain biking experience, offering participants a unique way to connect with nature (Siderelis et al., 2010), and acts as an important motivational factor (Taylor, 2010; Davidson and Stebbins, 2011; Lynch and Dibben, 2016). Despite this, mainstream health interventions rarely include outdoor adventure activities or extreme sports (Clough et al., 2016).

In summary, recent evidence suggests behavioral and motivational homogeneity within these types of populations should not be assumed; and the various ways of participating in mountain biking appear to belong on several points along the extreme sport continuum. Thrill-seeking may motivate some participants to engage in mountain biking. The natural environments in which these activities take place are thought to be both an important motivational factor as well as a catalyst for improved well-being. Evidence is growing regarding the potential for extreme sports to contribute to positive mental health; however, there is a shortage of evidence concerning mountain biking. The aim of this study therefore was to describe the characteristics of mountain bikers, their engagement methods, and perceived benefits to psychological well-being.

METHODS

Participants and Procedure

This was a retrospective cross-sectional study utilizing an online survey to gather quantitative data on demographics, riding habits, preferences and motivations of a self-selecting sample of international mountain bikers. The only inclusion criterion was being a mountain biker aged 16 or over. Ethical approval was granted by Leeds Beckett University prior to the dissemination of the survey in June 2016. Informed consent was gained from each participant by ticking a check box before being able to continue with the survey. The survey comprised 68 separate items and was presented over 7 pages. A snowball sampling method was utilized (Bryman, 2016) by means of social media (Facebook and Twitter), and the survey remained live for three weeks.

Measure

A standardized measure of the characteristics of mountain bikers and their engagement was not available. Quantitative studies on other extreme or adventure sports have usually used or adapted measures developed to explore personality traits or other psychological constructs (e.g., Llewellyn et al., 2008; Skår et al., 2008; Castanier et al., 2010; Hill et al., 2017). Due to this incongruity in current measurement, a survey tool was developed to provide an activity-specific approach to understanding the characteristics of the mountain biking population and constructs behind participation at a less traditional level of analysis (see **Supplementary Material**).

Methodology and Construct Development

A sequential exploratory strategy (Cresswell, 2009) was mirrored in the study methodology. Step one: a rigorous synthesis of existing literature (prior to April 2016) on action or adventure activities (both qualitative and quantitative) facilitated the latent construct development of the survey. Step two: quantitative data collection, followed by analysis and interpretation. The construct development of the survey followed three specific stages as identified by Bearman and Dawson (2013): (1) key themes were identified in existing literature, (2) any inconsistencies or contradictions were acknowledged, (3) themes were ordered into over-arching categories that became themed sections of the survey. Steps were taken to address the potential for bias stemming from the subjective interpretation of context-dependent findings characteristic of qualitative synthesis; for example, emergent themes thought to be irrelevant to mountain biking were nonetheless included. These sections of the survey comprised statements with five Likert response options (Likert et al., 1993) ranging from "Strongly Agree" to "Strongly Disagree," with a mid-point of "Neutral." An additional section of the survey captured nominal data such as demographics and riding frequency of participants. Three mountain bikers piloted the survey. Minor adjustments were made included the re-wording of some questions and the reversal of some scales; and a small number of additional questions were added.

Data Analysis

Our study presents selected data from the larger survey. The "Agree" and "Strongly Agree" responses to Likert scale questions were merged, as were the "Disagree" and "Strongly Disagree" responses, to create a clear picture of participant attitude and to mitigate against central tendency bias. Responses were coded and data was analyzed descriptively using SPSS version 24 (SPSS Inc, Chicago, USA). To facilitate a deeper investigation, the sample was then split into three sub-sets of dichotomous variables. These were: (1) those who had ridden downhill in the past 2 years (*downhill riders*) and those who had not (*non-downhill riders*); (2) males and females; and (3) those aged 35 or under (*younger riders*), and those aged 36 or over (*older riders*). These categories were decided on for the following reasons: (1) comparing downhill riders with non-downhill riders may highlight differences between participants who engage in what is arguably the most high-risk form of mountain biking, compared with those who do not. (2) The literature has consistently shown that males dominate this activity (e.g., Cycling UK, 2017), therefore analyzing differences between males and females may provide some insight. (3) Previous literature has argued that as participants age, their motivations may change (e.g., Willig, 2008), therefore analyzing how age influences the results may facilitate a description of these differences. These three sub-samples were all measured using clear, unambiguous categorical data. The Likert items were treated as ordinal data, and conclusions drawn from these single items have been treated cautiously (Gilem and Gilem, 2003), and for the most part only in conjunction with other Likert items or alongside the nominal data results.

The use of parametric or non-parametric tests when analyzing Likert data is much debated (Sullivan and Artino, 2013). Certain researchers claim that both methods hold comparable power if the sample size is large and meets the required assumptions; others argue that using parametric methods can never be justified (De Winter and Dodou, 2010). As Likert data is ordinal, non-parametric testing is arguably the more appropriate method of analysis. The Mann–Whitney *U*-test was used in this study to compare the responses within the independent samples (male/female; downhill/non-downhill; 35 years or under/36 years or over). Cohen's classification has been used as a standardized measure to interpret effect size. Mann–Whitney results are reported in the main body of this paper only if $p \leq 0.001$. See **Tables 1–3** for all Mann–Whitney test results.

FINDINGS

Participant Characteristics

Objective Participant Characteristics

The characteristics of the 1,484 active international mountain bikers recruited are described in **Table 4A**. Men made up just over 80% of the sample. The most well represented age group was 36–45 years. Just over half of the participants considered themselves to be of intermediate standard. Approximately 40% indicated that they had been riding for over a decade. Nearly 60% indicated that they had not participated in mountain biking as a child.

Participants were asked what type of mountain biking they had engaged in in the last 2 years, with the option of selecting more than one type (**Table 5A**). Those who ride cross-country

TABLE 1 | Results from Mann–Whitney *U*-tests comparing male and female rider responses.

	Mann–Whitney *U*	*Z*	Asymp. Sig. (2-tailed)	*n*	*r*
I participated in MTB as a child	95,719	−6.56	0.000	1,445	−0.17
Level	98,696	−5.84	0.000	1,448	−0.15
Age	126,372	−0.14	0.889	1,444	0.00
Length of time participating	101,654	−4.96	0.000	1,448	−0.13
Frequency of participation (winter)	115,815	−2.18	0.029	1,444	−0.06
Frequency of participation (summer)	117,036	−1.25	0.210	1,419	−0.03
Perceived risk in personal participation	120,333	−1.45	0.148	1,447	−0.04
Preference (group or alone)	123,487	−0.79	0.427	1,449	−0.02
I participate in MTB for the adrenaline rush	118,594	−2.34	0.019	1,449	−0.06
MTB fulfills my need for adventure	124,719	−0.73	0.465	1,447	−0.02
I enjoy the risk inherent in MTB	97,844	−6.37	0.000	1,448	−0.17
I am not a risk taker	120,684	−1.23	0.219	1,443	−0.03
I like appearing adventurous to others	120,734	−1.28	0.199	1,444	−0.03
MTB encourages me to explore my local countryside	124,882	−1.05	0.294	1,447	−0.03
I love being outdoors	126,075	−1.47	0.141	1,448	−0.04
MTB allows me to feel more connected to nature and the world around me	118,735	−2.19	0.029	1,442	−0.06
Being outdoors helps me to de-stress	126,183	−1.05	0.291	1,447	−0.03
If the weather in bad, I don't go riding	121,918	−0.99	0.324	1,445	−0.03
When I ride, my everyday worries fade away	123,681	−1.55	0.122	1,447	−0.04
I spend time practicing skills	124,968	−0.51	0.611	1,449	−0.01
I ride more casually	114,544	−2.47	0.014	1,444	−0.06
I enjoy bike maintenance	75,053	−11.18	0.000	1,445	−0.29
MTB is part of my identity	126,285	−0.31	0.760	1,447	−0.01
I suffer from mild mental health problems and use MTB as a coping strategy	108,266	−3.48	0.000	1,438	−0.09
I suffer from severe/enduring mental health problems and use MTB as a coping strategy	122,454	−0.72	0.473	1,440	−0.02
I would find it very depressing if I could no longer ride due to illness or injury	123,507	−1.76	0.078	1,447	−0.05
MTB is something I do to de-stress	124,196	−0.82	0.414	1,444	−0.02
MTB helps me to deal with negative thoughts and feelings	121,343	−1.62	0.105	1,447	−0.04
MTB makes me feel good about myself	119,500	−2.61	0.009	1,446	−0.07
I would stop MTBing if my friends stopped	126,407	−0.31	0.757	1,447	−0.01

MTB, mountain biking.

and trails made up over 90% of the sample; over half have participated in enduro and all-mountain; approximately 30% in downhill; and pump track, 4X and freeride collectively made up <20% of the sample. Over a third of the participants indicated that they prefer to ride in groups compared with ∼15% preferring to ride alone (**Table 5A**). Nearly half indicated that they have no preference. Approximately half of the participants indicated that the social aspect of mountain biking is important to them; however <4% of the participants indicated that they would stop engaging in mountain biking if their friends did not take part anymore (**Table 5B**).

Some disparities emerged when comparing the rider characteristics of males and females. Firstly, a Mann–Whitney test indicated that self-rated level was higher for males (M rank = 747) than for females (M rank = 586) ($U = 98{,}695$, $p < 0.001$, $r = 0.15$). To illustrate, ∼20% of females indicated that they were advanced or professional riders compared with 40% of males. A Mann–Whitney test also indicated that males (M rank = 745) have been riding for longer than females (M rank = 599) ($U = 101{,}654$, $p < 0.001$, $r = 0.13$). Demonstrated descriptively, ∼45% of males compared with 28% of females stated that they have been riding for more than a decade. Similarly, nearly 45% of males (M rank = 698) indicated they had participated in mountain biking as a child in comparison to only 20% of females (M rank = 874) ($U = 95{,}718$, $p < 0.001$ $r = 0.14$). The effect sizes of these differences are small, but of high statistical significance. Differences in the age range of males and females showed no statistical significance.

The participants were divided into two further independent samples: those who had taken part in downhill mountain biking in the past 2 years (*downhill riders*) and those who had not (*non-downhill riders*). A Mann–Whitney test revealed that there was a greater proportion of younger riders (M rank = 641) within the downhill rider sample ($U = 186{,}947$, $p < 0.001$, $r = 0.18$). A Mann–Whitney test also indicated that self-rated level of ability was higher for downhill riders (M rank = 816) than for non-downhill riders (M rank = 709), ($U = 200{,}083$, $p < 0.001$, $r = 0.13$), and similarly that a higher proportion of those who ride

TABLE 2 | Results from Mann–Whitney *U*-tests comparing *younger rider* and *older rider* responses.

	Mann–Whitney *U*	*Z*	Asymp. Sig. (2-tailed)	*n*	*r*
I participated in MTB as a child	146,594	−13.90	0.000	1,467	−0.36
Level	235,138	−0.37	0.712	1,470	−0.01
Length of time participating	160,322	−10.78	0.000	1,470	−0.28
Frequency of participation (winter)	204,611	−4.54	0.000	1,466	−0.12
Frequency of participation (summer)	221,507	−1.26	0.209	1,441	−0.03
Perceived risk in personal participation	231,544	−0.80	0.423	1,469	−0.02
Preference (group or alone)	215,189	−3.25	0.001	1,471	−0.08
I participate in MTB for the adrenaline rush	205,395	−6.18	0.000	1,471	−0.16
MTB fulfills my need for adventure	220,453	−3.47	0.001	1,469	−0.09
I enjoy the risk inherent in MTB	214,913	−3.51	0.000	1,470	−0.09
I am not a risk taker	209,528	−3.86	0.000	1,465	−0.10
I like appearing adventurous to others	185,559	−7.61	0.000	1,466	−0.20
MTB encourages me to explore my local countryside	235,351	−0.63	0.528	1,469	−0.02
I love being outdoors	235,819	−1.39	0.165	1,470	−0.04
MTB allows me to feel more connected to nature and the world around me	227,362	−2.03	0.042	1,464	−0.05
Being outdoors helps me to de-stress	235,319	−1.37	0.171	1,469	−0.04
If the weather in bad, I don't go riding.	230,560	−0.97	0.332	1,467	−0.03
When I ride, my everyday worries fade away	228,449	−2.74	0.006	1,469	−0.07
I spend time practicing skills	193,142	−6.49	0.000	1,471	−0.17
I ride more casually	214,151	−3.24	0.001	1,466	−0.08
I enjoy bike maintenance	217,250	−3.06	0.002	1,467	−0.08
MTB is part of my identity	234,503	−0.57	0.569	1,469	−0.01
I suffer from mild mental health problems and use MTB as a coping strategy	215,064	−2.82	0.005	1,460	−0.07
I suffer from severe/enduring mental health problems and use MTB as a coping strategy	220,940	−2.39	0.017	1,460	−0.06
I would find it very depressing if I could no longer ride due to illness or injury	235,828	−0.51	0.609	1,462	−0.01
MTB is something I do to de-stress	233,671	−0.70	0.483	1,466	−0.02
MTB helps me to deal with negative thoughts and feelings	231,794	−1.10	0.271	1,469	−0.03
MTB makes me feel good about myself	227,958	−2.26	0.024	1,468	−0.06
I would stop MTBing if my friends stopped	233,761	−0.91	0.364	1,469	−0.02

MTB, mountain biking.

downhill (M rank = 664) also participated in mountain biking as a child (U = 197,666, $p < 0.001$, $r = 0.14$). Again, the effect sizes are small, but of high statistical significance. Downhill riders tented to ride more frequently, though the statistical significance is negligible.

Two additional independent samples were compared: those aged 35 years or younger (*younger riders*); and those aged 36 years or older (*older riders*). A Mann–Whitney test showed that older riders (M rank = 813) tended to have been riding for a longer period of time that younger riders (M rank = 575) (U = 160,321, $p < 0.001$), with a small-to-medium effect size ($r = 0.28$). Furthermore, approximately 66% of younger participants had ridden as a child, compared with just under 30% of participants over 35 years old. A Mann–Whitney test indicated that this had high statistical significance with a moderate effect size (U = 146,594, $p < 0.001$, $r = 0.36$).

Subjective Participant Characteristics

The subjective characteristics of the full sample and of the subsets are described in **Table 4B**. The majority of participants indicated that mountain biking forms part of their identity. The proportion in agreement was higher for downhill riders (M rank = 791) than for non-downhill riders (M rank = 720) (U = 210,622, $p < 0.001$, $r = 0.13$), but any differences between males and female or younger and older riders showed no statistical significance. Just over half of participants indicated that they wanted others to see them as adventurous, with a higher level of agreement for the younger riders (M rank = 840) in comparison to the older riders (M rank = 682) with a small effect size (U = 185,559, $p < 0.001$ $r = 0.20$).

Regarding risk, just over 20% of the participants indicated that they did not consider themselves to be risk-takers, and approximately half indicated that they were risk-takers. A Mann–Whitney test showed that younger riders (M rank = 677) indicated that they were risk-takers at a higher rate than older riders (M rank = 760) (U = 209,527, $p < 0.001$, $r = 0.10$). Downhill riders (M rank = 647) were also more likely to consider themselves to be risk takers compared with the non-downhill rider sample (M rank = 780), (U = 190,000, $p < 0.001$, $r = 0.16$) (see **Figure 1**). Differences in the male and

TABLE 3 | Results from Mann–Whitney *U*-tests comparing *downhill rider* and *non-downhill rider* responses.

	Mann–Whitney *U*	*Z*	Asymp. Sig. (2-tailed)	*n*	*r*
I participated in MTB as a child	197,666	−5.38	0.000	1,480	−0.14
Level	200,083	−5.05	0.000	1,483	−0.13
Age	186,948	−7.02	0.000	1,471	−0.18
Length of time participating	229,444	−0.54	0.588	1,483	−0.01
Frequency of participation (winter)	219,372	−1.85	0.064	1,479	−0.05
Frequency of participation (summer)	211,031	−2.57	0.010	1,454	−0.07
Perceived risk in personal participation	181,036	−7.88	0.000	1,482	−0.20
Preference (group or alone)	226,862	−1.00	0.317	1,484	−0.03
I participate in MTB for the adrenaline rush	201,172	−6.23	0.000	1,484	−0.16
MTB fulfills my need for adventure	221,964	−2.35	0.019	1,482	−0.06
I enjoy the risk inherent in MTB	185,534	−7.55	0.000	1,483	−0.20
I am not a risk taker	190,000	−6.05	0.000	1,478	−0.16
I like appearing adventurous to others	223,629	−1.31	0.190	1,479	−0.03
MTB encourages me to explore my local countryside	229,013	−1.19	0.235	1,482	−0.03
I love being outdoors	233,095	−0.16	0.875	1,483	0.00
MTB allows me to feel more connected to nature and the world around me	223,380	−2.03	0.042	1,477	−0.05
Being outdoors helps me to de-stress	232,183	−0.60	0.549	1,482	−0.02
If the weather in bad, I don't go riding	206,068	−4.06	0.000	1,484	−0.11
When I ride, my everyday worries fade away	230,131	−0.91	0.362	1,481	−0.02
I spend time practicing skills	183,169	−7.39	0.000	1,484	−0.19
I ride more casually	191,068	−5.98	0.000	1,479	−0.16
I enjoy bike maintenance	231,005	−0.30	0.764	1,480	−0.01
MTB is part of my identity	210,622	−4.86	0.000	1,482	−0.13
I suffer from mild mental health problems and use MTB as a coping strategy	211,400	−2.75	0.006	1,473	−0.07
I suffer from severe/enduring mental health problems and use MTB as a coping strategy	216,315	−2.42	0.016	1,475	−0.06
I would find it very depressing if I could no longer ride due to illness or injury	231,241	−0.62	0.538	1,482	−0.02
MTB is something I do to de-stress	227,977	−1.07	0.283	1,479	−0.03
MTB helps me to deal with negative thoughts and feelings	230,291	−0.55	0.581	1,482	−0.01
MTB makes me feel good about myself	226,749	−1.51	0.130	1,481	−0.04
I would stop MTBing if my friends stopped	228,949	−1.04	0.298	1,482	−0.03

MTB, mountain biking.

female responses showed little statistical significance. 65.6% in total agreed with the statement "I enjoy the element of risk or danger inherent in mountain biking." Mann–Whitney tests indicated statistical significance in the differences in responses between all of the sub-samples: downhill riders (M rank = 848) showed a greater preference than non-downhill riders (M rank = 695) (U = 185,533, $p < 0.001$, $r = 0.20$); as did males (M rank = 748) compared with females (M rank = 580), (U = 97,843, $p < 0.001$, $r = 0.17$); and younger riders (M rank = 782) compared with older riders (M rank = 713), (U = 214,912, $p < 0.001$, $r = 0.09$) (see **Figure 2**).

Engagement Characteristics

Table 5A describes nominal data capturing various engagement characteristics, described in more detail in the following sections.

Riding Frequency and Style

Approximately 40% of the participants indicated that they ride twice a week or more in the winter season, and a similar number claimed to ride once or twice a fortnight (**Table 5A**). Participants reported riding more often in the summer season, with nearly 70% of participants claiming to ride twice a week or more. Summer season riding frequency was similar across all independent samples, however, Mann–Whitney tests indicated younger riders (M rank = 800) participated more frequently than older riders (M rank = 701) in the Winter (U = 185,533; $p < 0.001$, $r = 0.12$). Males and downhill riders also rode more frequently in the winter, though the statistical significance was slight.

Risk and Skill-Based Engagement

Regarding perceptions of risk; 0.5% of the participants indicated that there is "no risk" in their mountain biking participation; ∼30% indicated "a little risk"; nearly 60% "moderate risk"; and 9% "substantial risk" (**Table 5B**). A Mann–Whitney test indicated that downhill riders (M rank = 856) considered there to be more risk in their participation than non-downhill riders (M rank = 691), (U = 181,036, $p < 0.001$, $r = 0.20$). To illustrate, ∼16% of the downhill riders considered there to be

TABLE 4A | Participant characteristics.

		Total		DH		Non-DH		Male		Female		Younger riders (≤35)		Older riders (>35)	
		n = 1,484		*n* = 454		*n* = 1,030		*n* = 1,244		*n* = 205		*n* = 480		*n* = 991	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Gender	Female	205	13.8	50	11	155	15					66	13.8	139	14
	Male	1,244	83.8	392	86.3	852	82.7					405	84.4	834	84.2
	Prefer not to disclose	25	1.7	8	1.8	17	1.7					6	1.3	13	1.3
	Total	1,474	99.3	450	99.1	1,024	99.4					477	99.4	986	99.5
Age	16-25	145	9.8	68	15	77	7.5	132	10.6	10	4.9				
	26-35	335	22.8	137	30.2	198	19.2	273	21.9	56	27.3				
	36-45	538	36.6	165	36.3	373	36.2	456	36.7	77	37.6				
	46-55	369	25.1	71	15.6	298	28.9	302	24.3	54	26.3				
	56+	84	5.7	9	2	75	7.3	76	6.1	8	3.9				
	Total	1,471	99.1	450	99.1	1,021	99.1	1,239	99.6	205	100				
Level	Beginner	80	5.4	11	2.4	69	6.7	55	4.4	22	10.7	31	6.5	47	4.7
	Intermediate	844	56.9	233	51.3	611	59.3	687	55.2	139	67.8	268	55.8	570	57.5
	Advanced & Pro	559	37.7	210	46.3	349	33.9	502	40.4	43	21	181	37.7	373	37.6
	Total	1,483	99.9	455	100	1,029	99.9	1,244	100	204	99.5	480	100	990	99.9
Length of time as participant	Less than a year	68	4.6	17	3.7	51	5	49	3.9	17	8.3	33	6.9	34	3.4
	Between 1 and 5 years	503	33.9	154	33.9	349	33.9	403	32.4	88	42.9	235	49	263	26.5
	6–10 years	281	18.9	103	22.7	178	17.3	229	18.4	43	21	98	20.4	180	18.2
	Over 10 years	631	42.5	179	39.4	452	43.9	562	45.2	57	27.8	113	23.5	514	51.9
	Total	1,483	99.9	453	99.8	1,030	100	1,243	99.9	205	100	479	99.8	991	100
I participated in MTB as a child	Yes	603	40.6	231	50.9	372	36.1	552	44.4	41	20	318	66.3	280	28.3
	No	877	59.1	221	48.7	656	63.7	689	55.4	163	79.5	161	33.5	708	71.4
	Total	1,480	99.7	452	99.6	1,028	99.8	1,241	99.8	204	99.5	479	99.8	988	99.7

"substantial risk" involved in comparison to just under 6% of the non-downhill riders (see **Figure 3**). Approximately 80% of the participants agreed that they engage in mountain biking because it gives them "an adrenaline rush." Mann–Whitney tests indicated that a larger proportion of downhill riders (M rank = 814) agreed with this statement compared with non-downhill riders (M rank = 711), (U = 201,172, $p < 0.001$, $r = 0.16$); likewise, a larger proportion of younger riders (M rank = 804) compared with older riders (M rank = 703) agreed (U = 205,394, $p < 0.001$, $r = 0.16$).

Regarding skill-related engagement, ∼20% of the total sample agreed with the statement "I do not concentrate on technical skills; I ride more casually." A larger proportion of non-downhill riders (M rank = 780) agreed with this statement compared with downhill riders (M rank = 650), (U = 191,068, $p < 0.001$, $r = 0.16$) and similarly a larger proportion of older riders (M rank = 756) compared with younger riders (M rank = 687), (U = 214,151, $p < 0.005$ $r = 0.08$). Just over half of the participants stated that they regularly spend time learning and practicing technical skills. Downhill riders (M rank = 854) indicated that they spend more time practicing technical skills than non-downhill riders (M rank = 693), (U = 183,169, $p < 0.001$, $r = 0.19$); similarly, younger riders (M rank = 829) in comparison to older riders (M rank = 691), (U = 193,141, $p < 0.001$, $r = 0.17$). Just over 66% of the participants agreed with the statement "I enjoy the bike maintenance aspect of this activity" (**Table 5C**). A Mann–Whitney test showed that males (M rank = 765) indicated a stronger preference for bike maintenance activities in comparison to females (M rank = 470), (U = 75,052, $p < .001$), with a moderate effect size ($r = 0.29$). Similarly, but with a smaller effect size, younger riders (M rank = 774) indicated a stronger preference for bike maintenance in comparison to older riders (M rank = 714), (U = 217,250, $p < 0.001$, r = 0.08).

Perceived Well-Being Outcomes

Participants completed a range of questions related to the mountain biking environment (**Table 6A**). Almost 100% of the participants agreed that they "love being outdoors," and over 98% of the participants indicated that being outdoors helps

TABLE 4B | Subjective participant characteristics.

		Total		Downhill riders		Non-downhill riders		Male		Female		Younger riders (≤35)		Older riders (>35)	
		n = 1,484		*n* = 455		*n* = 1,030		*n* = 1,244		*n* = 205		*n* = 480		*n* = 991	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Mountain biking is part of my identity	Agree	1,275	85.9	419	92.3	856	83.1	1068	85.9	175	85.4	416	86.7	849	85.7
	Neutral	186	12.5	28	6.2	158	15.3	160	12.9	25	12.2	57	11.9	127	12.8
	Disagree	21	1.4	5	1.1	16	1.6	14	1.1	5	2.4	6	1.3	14	1.4
	Total	1,482	99.9	452	99.6	1,030	100	1,242	99.8	205	100	479	99.8	990	99.9
I want others to see me as an adventurous person	Agree	828	55.8	266	58.6	562	54.6	685	55.1	124	60.5	333	69.4	485	48.9
	Neutral	530	35.7	151	33.3	379	36.8	453	36.4	65	31.7	130	27.1	398	40.2
	Disagree	121	8.2	36	7.9	85	8.3	101	8.1	16	7.8	17	3.5	103	10.4
	Total	1,479	99.7	453	99.8	1,026	99.6	1,239	99.6	205	100	480	100	986	99.5
I do not consider myself to be a risk taker	Agree	310	20.9	61	13.4	249	24.2	249	20	52	25.4	79	16.5	230	23.2
	Neutral	418	28.2	111	24.4	307	29.8	355	28.5	54	26.3	126	26.3	290	29.3
	Disagree	750	50.5	280	61.7	470	45.6	634	51	99	48.3	275	57.3	465	46.9
	Total	1,478	99.6	452	99.6	1,026	99.6	1,238	99.5	205	100	480	100	985	99.4
I enjoy the element of risk or danger inherent in mountain biking	Agree	974	65.6	362	79.7	612	59.4	852	68.5	99	48.3	346	72.1	616	62.2
	Neutral	366	24.7	69	15.2	297	28.8	296	23.8	61	29.8	90	18.8	276	27.9
	Disagree	143	9.6	23	5.1	120	11.7	95	7.6	45	22	43	9	99	10
	Total	1,483	99.9	454	100	1,029	99.9	1,243	99.9	205	100	479	99.8	991	100

them to de-stress. Nearly 90% of the participants agreed that mountain biking makes them feel more connected to nature and the world around them. Over 90% of the participants agreed that participating in mountain biking has made them more likely to explore their local countryside. Mann–Whitney tests revealed that these figures remained stable irrespective of the confounding factors of age, gender or type of rider. Approximately 12% of the total sample agreed that they do not ride if the weather is bad. A Mann–Whitney test showed that a higher proportion of non-downhill riders (M rank = 766) choose not to ride in bad weather in comparison to downhill riders (M rank = 682), ($U = 206{,}068$, $p < 0.001$, $r = 0.11$).

Participants also completed a range of questions regarding perceived well-being outcomes in relation to their engagement in mountain biking (**Table 6B**). Nearly 90% of participants agreed that mountain biking makes them feel good about who they are. Females, younger riders and downhill riders tended to agree at a higher rate though statistical significance was negligible. Over 80% agreed that participating in mountain biking helps them to deal with negative thoughts or feelings, and over 90% indicated that it is something they do to de-stress; figures that remained stable across the independent sub-samples. Approximately 93% of participants agreed with the statement "when I ride my everyday worries fade away," and nearly 95% of the total participants stated that they would find it depressing if they could no longer ride due to illness or injury; again, with the figures remaining steady across sub-samples.

Participants responded to questions directly related to pre-existing and self-defined mental health problems (**Table 6C**). 33.8% of the participants agreed with the statement "I have mild mental health problems (such as stress, depression, or anxiety) and use mountain biking as a coping strategy." A Mann-Whitney test indicated that the difference between the female (M rank = 806) and male (M rank = 705) responses was statistically significant ($U = 108{,}266$, $p < 0.001$), though with small effect size ($r = 0.09$). Younger riders and downhill riders also agreed with this statement at a slightly higher rate, though with minor statistical significance and small effect size. 7.3% of the participants agreed with the statement "I suffer from severe or enduring mental health problems and use mountain biking as a coping strategy." Again, younger riders and downhill riders agreed with this statement at a higher rate, though with low statistical significance and effect size. Male and female responses displayed little variance.

Summary of Significant Differences Within the Sub-samples

Male and Female Riders

Our results show that males tended to have been riding for longer than females and rated themselves at a higher ability level. Males were also more likely to have ridden as children. Males indicated that they enjoy the risk involved more than females, as well as the bike maintenance aspect of the activity. Females indicated that mountain biking helped them to deal with mild mental health difficulties at a higher rate than men. All of these differences showed only small effect sizes, with the exception of the male preference for bike maintenance, which displayed a moderate

TABLE 5A | Engagement characteristics.

		Total		Downhill riders		Non-downhill riders		Male		Female		Younger riders (≤35)		Older riders (>35)	
		n = 1,484		*n* = 455		*n* = 1,030		*n* = 1,244		*n* = 205		*n* = 480		*n* = 991	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Riding frequency in Winter season	Twice a week or more	608	41	197	43.4	411	39.9	512	41.2	77	37.6	163	34	439	44.3
	Weekly to fortnightly	590	39.8	185	40.7	405	39.3	509	40.9	72	35.1	198	41.3	386	39
	Once a month or less	281	18.9	71	15.6	210	20.4	218	17.5	56	27.3	119	24.8	161	16.2
	Total	1,479	99.7	453	99.8	1,026	99.6	1,239	99.6	205	100	480	100	986	99.5
Riding frequency in Summer season	Twice a week or more	1,029	69.3	339	74.7	690	67	865	69.5	135	65.9	323	67.3	694	70
	Weekly to fortnightly	355	23.9	97	21.4	258	25	298	24	52	25.4	127	26.5	227	22.9
	Once a month or less	70	4.7	15	3.3	55	5.3	55	4.4	14	6.8	23	4.8	47	4.7
	Total	1,454	98	451	99.3	1,003	97.4	1,218	97.9	201	98	473	98.5	968	97.7
Type of MTB taken part in (in last 2 years)	Cross Country & T rail	1,379	92.9	396	87.2	983	95.4	1,148	92.3	198	96.6	431	89.8	936	94.5
	Enduro & All-Mountain	835	56.3	361	79.5	474	46	732	58.8	79	38.5	305	63.5	520	52.5
	Downhill	454	30.6	454	100	0	0	392	31.5	50	24.4	205	41.7	245	24.7
	Pump track, 4X, Freeride	277	18.7	181	39.9	96	9.3	240	19.3	31	15.1	127	26.5	147	14.8
	Total	1,484	100	454	100	1,030	100	1,244	100	205	100	480	100	991	100
Riding preference	Alone	224	15.1	42	9.3	182	17.7	194	15.6	25	12.2	64	13.3	158	15.9
	Group	540	36.4	188	41.4	352	34.2	440	35.4	82	40	206	42.9	329	33.2
	No preference	720	48.5	224	49.3	496	48.2	610	49	98	47.8	210	43.8	504	50.9
	Total	1,484	100	454	100	1,030	100	1,244	100	205	100	480	100	991	100

effect size. Differences between the genders displayed the least variability amongst the three sub-samples.

Younger and Older Riders

Younger riders were more likely to have ridden as children, participate more in the winter, and practice skills more often than older riders. Younger riders were also more likely than older riders to consider themselves to be risk-takers, want others to see them as adventurous, be motivated by the "adrenaline rush," and enjoy the risk and danger inherent in mountain biking. Furthermore, younger riders showed a preference for bike maintenance activities. Older riders indicated that they had been riding for longer than younger riders, and were more likely to ride more casually. The differences displayed small to medium effect sizes.

Downhill Riders and Non-downhill Riders

Downhill riders tended to be younger, were more likely to have ridden as children, and indicated that they were at a more proficient ability level than non-downhill riders. Downhill riders indicated that they spend more time practicing skills and are more likely to ride even when the weather is bad in comparison to non-downhill riders; who were conversely more likely to state they ride more casually. Furthermore, downhill riders expressed that there is more risk involved in their participation than non-downhill riders, and they are more likely to consider themselves to be risk-takers as well as enjoying the risk and danger involved. Downhill riders were also more motivated to engage for an "adrenaline rush" than non-downhill riders, and more likely to state that mountain biking forms part of their identity. The differences displayed small to medium effect sizes.

DISCUSSION

This study aimed to describe the characteristics of mountain biking participants, their engagement methods, and perceived benefits of mountain biking on mental health and well-being. Our findings have succeeded in describing the overall sample as well as highlighting differences and similarities between certain paired groups of mountain bikers. Initially, this discussion elaborates on the characteristics of the participants and their engagement methods. Subsequently, we draw upon these findings to support our discussion of the engagement

TABLE 5B | Risk and sensation-seeking engagement characteristics.

		Total		Downhill riders		Non-downhill riders		Male		Female		Younger riders (≤35)		Older riders (>35)	
		n = 1,484		*n* = 455		*n* = 1,030		*n* = 1,244		*n* = 205		*n* = 480		*n* = 991	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Perceived risk in personal participation	No risk	8	0.5	1	0.2	7	0.7	7	0.6	1	0.5	3	0.6	5	0.5
	A little risk	455	30.7	88	19.4	367	35.6	372	29.9	73	35.6	142	29.6	308	31.1
	Moderate risk	886	59.7	291	64.1	595	57.8	752	60.5	114	55.6	285	59.4	595	60
	Substantial risk	133	9	73	16.1	60	5.8	111	8.9	17	8.3	48	10	83	8.4
	Total	1,482	99.9	453	99.8	1,029	99.9	1,242	99.8	205	100	478	99.6	991	100
I participate in MTB because it gives me an adrenaline rush	Agree	1,195	80.5	409	90.1	786	76.3	1,016	81.7	154	75.1	431	89.8	755	76.2
	Neutral	238	16	40	8.8	198	19.2	192	15.4	38	18.5	41	8.5	194	19.6
	Disagree	51	3.4	5	1.1	46	4.5	36	2.9	13	6.3	8	1.7	42	4.2
	Total	1,484	100	454	100	1,030	100	1,244	100	205	100	480	100	991	100

TABLE 5C | Skill-based engagement characteristics.

		Total		Downhill riders		Non-downhill riders		Male		Female		Younger riders (≤35)		Older riders (>35)	
		n = 1,484		*n* = 455		*n* = 1,030		*n* = 1,244		*n* = 205		*n* = 480		*n* = 991	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
I do not concentrate on technical skills; I ride more casually	Agree	305	20.6	55	12.1	250	24.3	243	19.5	54	26.3	79	16.5	225	22.7
	Neutral	410	27.6	117	25.8	293	28.4	344	27.7	60	29.3	128	26.7	280	28.3
	Disagree	764	51.5	281	61.9	483	46.9	652	52.4	91	44.4	273	56.9	481	48.5
	Total	1,484	100	453	99.8	1,026	99.6	1,239	99.6	205	100	480	100	986	99.5
I regularly spend time learning/practicing technical skills	Agree	796	53.6	307	67.6	489	47.5	664	53.4	111	54.1	317	66	469	47.3
	Neutral	462	31.1	109	24	353	34.3	402	32.3	53	25.9	110	22.9	350	35.3
	Disagree	226	15.2	38	8.4	188	18.3	178	14.3	41	20	53	11	172	17.4
	Total	1,484	100	454	100	1,030	100	1,244	100	205	100	480	100	991	100
I enjoy the Bike maintenance of this activity	Agree	986	66.4	307	67.6	679	65.9	889	71.5	71	34.6	346	72.1	631	63.7
	Neutral	282	19	78	17.2	204	19.8	222	17.8	56	27.3	74	15.4	205	20.7
	Disagree	121	14.3	69	15.2	143	13.9	130	10.5	77	37.6	59	12.3	152	15.3
	Total	1,484	100	454	100	1,026	99.6	1,241	99.8	204	99.5	479	99.8	988	99.7

methods and rider attitudes related to risk and skill; the disproportion of female to male riders; and perceived well-being benefits.

Participant Characteristics and Engagement

Our results regarding gender and age are congruent with other similar studies (e.g., Skår et al., 2008; Cycling UK, 2017; Hill et al., 2017); and confirm that mountain biking is a male-dominated sport, largely performed by those aged 36–55. A significantly higher percentage of the younger riders engaged in mountain biking as a child compared with the older riders, lending weight to the claim that mountain biking has boomed in popularity over the last 30 years (Moularde and Weaver, 2016; Poulson, 2016). Trail riding and cross-country were the most popular methods of engaging in mountain biking, with downhill one of the least common, again mirroring recent findings (Cycling UK, 2017). Participants generally reported having been involved in mountain biking for many years, in particular the older riders; indicating that they participate regularly throughout the year. Again, this is congruent with other findings (Taylor, 2010; Cycling UK, 2017). Many studies have highlighted the central importance of the social aspect of mountain biking and similar sports (e.g., Willig, 2008; International Mountain Biking Association, 2010; Moularde and Weaver, 2016; Cycling UK, 2017; Frühauf et al., 2017). Our findings show that although the social aspect is important; there is some apathy regarding riding alone or with others, and <4% claimed they would stop participating if their friends stopped. Further study is needed; however, we suggest that although camaraderie may be a motivator to a certain extent, it is not a vital aspect of the activity.

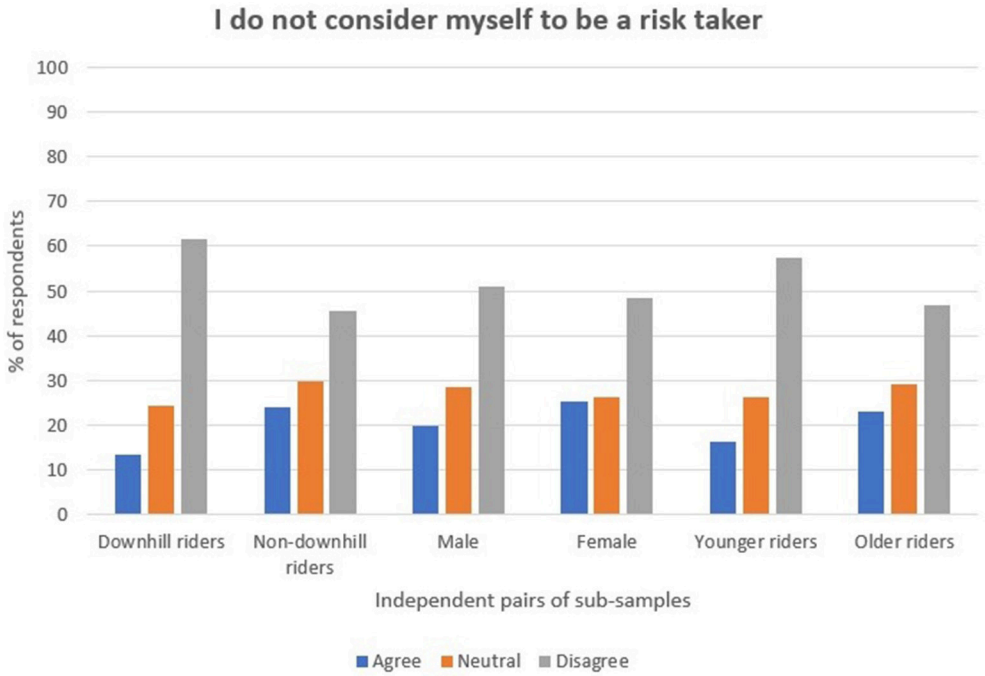

FIGURE 1 | Participants' perception of themselves as risk takers.

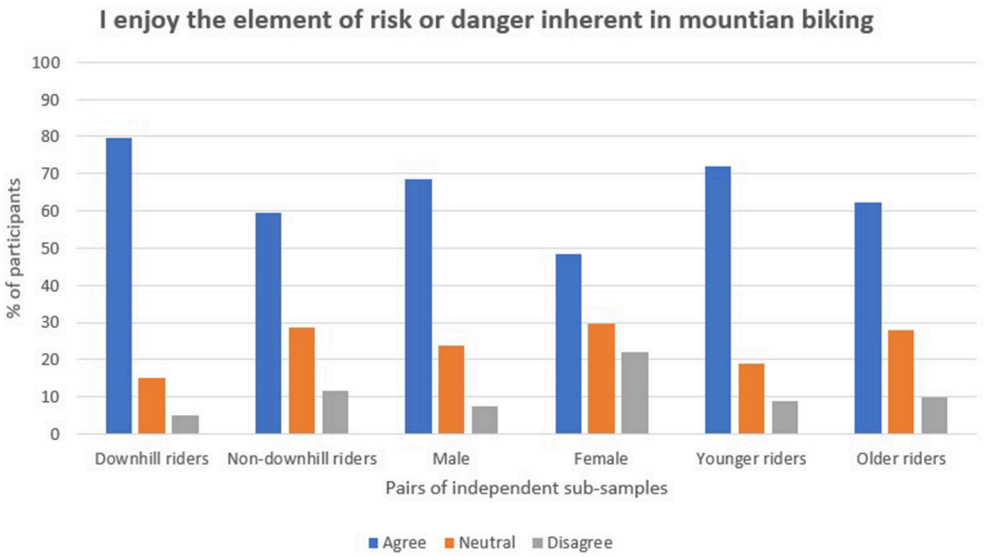

FIGURE 2 | Participants' enjoyment of the risk or danger in mountain biking.

Attitudes to Risk

The mountain bikers surveyed displayed variability in their perception and experience of risk, supporting recent studies (e.g., Jones et al., 2015; Lynch and Dibben, 2016; Brymer and Schweitzer, 2017; Cycling UK, 2017). Younger riders were more likely to enjoy the level of risk and danger, view themselves as risk-takers, as well as being more motivated by the adrenaline rush, compared with older riders. Younger riders were also more likely to spend time practicing technical skills. The study highlighted similar findings amongst downhill riders. Downhill riding is one of the most high-risk methods of engaging in mountain biking (Becker et al., 2013; Hagen, 2013; Becker and Moroder, 2017). Predictably, those who have recently participated in downhill mountain biking were more likely to

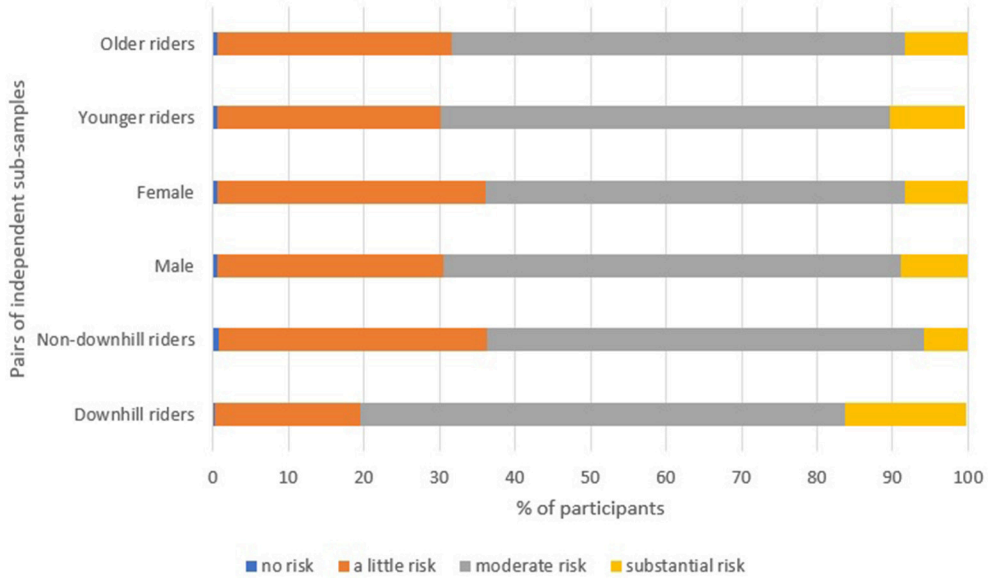

FIGURE 3 | Participants' perceived risk in personal participation of mountain biking.

indicate a higher level of risk in their participation than those who had not. Downhill riders, in a similar way to younger riders, were also more likely to enjoy the risk involved, consider themselves to be risk-takers, and be motivated by an "adrenaline rush." To be able to engage relatively safely in an activity that poses significant risk such as downhill riding, one must mitigate against the risk. One way of doing this is to ensure that relevant skills are developed sufficiently through practice and commitment to the activity. Downhill riders did tend to indicate that they were of a higher level of ability and were more likely to spend time practicing technical skills than those who do not participate in downhill riding. They were also slightly more likely to ride more often and in all weather. These findings are compatible with the theory that participants of extreme or adventure sports are capable of matching their skill level to their method of engagement (Llewellyn and Sanchez, 2008; Taylor, 2010; Lynch and Dibben, 2016; Frühauf et al., 2017); and they typically ensure that risks are within personal capabilities (Willig, 2008; Jones et al., 2015). Crucially, these younger riders and downhill riders suggest they experience something pleasurable from the experience of high-risk engagement. It is possible that an awareness of danger contributes to the value of the extreme sport experience for some individuals; that the tangible presence of risk adds to a sense of pushing personal limitations, contributing to self-esteem and confidence (Willig, 2008; Taylor, 2010). Similarly, Jones et al. (2015) argues that facing a challenge on the edge of one's abilities can provide the participant with a sense of gratification and increase self-efficacy. As such, experiencing enjoyment alongside fear may not be as strange or negative a phenomenon as it outwardly appears (Dodson, 1996; Lyng, 2005; Willig, 2008). A detailed, precise study concentrating on the benefits of perceived risk-taking in mountain biking could further enhance this line of argument.

Seemingly inconsistent with the assumption that males take more risks than females (Byrnes et al., 1999; Weber et al., 2002); males and females in this study did not differ in their perception of themselves as risk-takers or of the risk involved in their participation. Neither did they differ in how much they are motivated by an adrenaline rush. A more nuanced finding, however, is that males, similar to younger riders and downhill riders, were more likely to indicate that they enjoy the level of perceived risk. This suggests that although subjective risk-taking behavior is analogous across both genders; male mountain bikers appear to be slightly more comfortable with the perceived risk or danger. This could support Weber et al.'s (2002) claim that men generally expect more benefits to arise following risk taking, including within recreational domains. We can again incorporate the concept of enactive task-mastery here; that is, positive experiences that occur through successfully testing one's skills in challenging situations. Our study found that male mountain bikers tended to have been riding for longer, consider themselves more advanced, and were more likely to have ridden as children. It is arguable therefore that these factors could be affording men more opportunities for experiences of enactive task-mastery; that is, providing them with more lived experience of the benefits which are realized by pushing ones limits and taking measured risks within the sport. Again, a more nuanced study would further enrich this study's preliminary findings.

TABLE 6A | The mountain biking environment.

		Total		Downhill riders		Non-downhill riders		Male		Female		Younger riders (≤35)		Older riders (>35)	
		n = 1,484		*n* = 455		*n* = 1,030		*n* = 1,244		*n* = 205		*n* = 480		*n* = 991	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Being outdoors helps me to de-stress	Agree	1,463	98.6	446	98.2	1,017	98.7	1,225	98.5	204	99.5	471	98.1	979	98.8
	Neutral	17	1.1	6	1.3	11	1.1	15	1.2	1	0.5	9	1.9	8	0.8
	Disagree	2	0.1	1	0.2	1	0.1	2	0.2	0	0	0	0	2	0.2
	Total	1,482	99.9	453	99.8	1,029	99.9	1,242	99.8	205	100	480	100	989	99.8
Mountain biking makes me feel more connected to nature & the world around me	Agree	1,317	88.7	392	86.3	925	89.8	1,095	88	189	92.2	415	86.5	891	89.9
	Neutral	148	10	54	11.9	94	9.1	135	10.9	11	5.4	59	12.3	87	8.8
	Disagree	12	0.8	6	1.3	6	0.6	10	0.8	2	1	4	0.8	8	0.8
	Total	1,477	99.5	452	99.6	1,025	99.5	1,240	99.7	202	98.5	478	99.6	986	99.5
Mountain biking has made me more likely to explore my local countryside	Agree	1,390	93.7	419	92.3	971	94.3	1,169	94	189	92.2	453	94.4	925	93.3
	Neutral	65	4.4	21	4.6	44	4.3	51	4.1	12	5.9	19	4	45	4.5
	Disagree	27	1.8	12	2.6	15	1.5	22	1.8	4	2	8	1.7	19	1.9
	Total	1,482	99.9	452	99.6	1,030	100	1,242	99.8	205	100	480	100	989	99.8
If the weather is bad, I won't go riding	Agree	180	12.1	36	7.9	144	14	156	12.5	21	10.2	50	10.4	128	12.9
	Neutral	365	24.6	98	21.6	267	25.9	310	24.9	49	23.9	121	25.2	243	24.5
	Disagree	935	63	318	70	617	59.9	775	62.3	134	65.4	309	64.4	616	62.2
	Total	1,484	100	452	99.6	1,028	99.8	1,241	99.8	204	99.5	480	100	987	99.6
I love being outdoors	Agree	1,469	99	449	98.9	1,020	99	1,230	98.9	205	100	473	98.5	983	99.2
	Neutral	13	0.9	3	0.7	10	1	12	1	0	0	7	1.5	6	0.6
	Disagree	1	0.1	1	0.2	0	0	1	0.1	0	0	0	0	1	0.1
	Total	1,483	99.9	453	99.8	1,030	100	1,243	99.9	205	100	480	100	990	99.9

Gender Disparity

The opinions and experiences of males and females did not vary substantially. There were some differences however: males considered themselves to be at a higher level of riding ability, had been riding for longer, and were more likely to have ridden as children in comparison to females. Males also indicated that they enjoyed the risk and danger involved more than females, as discussed above. The most substantial variance however was regarding attitudes toward bike maintenance. There is a dearth of peer-reviewed literature regarding females and their attitudes to bike maintenance or mechanics, however, the popular press often states that female cyclists can find the mechanical world of bikes intimidating, and often lack the confidence to engage in this aspect of cycling (Milley, 2016). As such, females may not be experiencing the full freedom that cycling offers. Mountain biking is continually developing as a sport, largely due to technical innovation (Huybers-Withers and Livingston, 2010), and so if females dislike or are uncomfortable with the technical side, integral aspects of mountain biking may remain foreign to them. Furthermore, important (female) insights may be overlooked by the industry, hindering the development of this ever-evolving sport (Huybers-Withers and Livingston, 2010). Results from our study suggest that females are less likely than males to participate in mountain biking as a child; it is possible, therefore, that females are also less likely to have engaged in any form of bike maintenance as a child. Female bike mechanics have argued that because girls are not taught how to fix their bikes when they are younger, they lack the confidence to learn these skills in later life[1] Female-only skill-based groups, workshops and scholarships are opening up across the globe in order to tackle this, where women are supported to learn new skills in empathetic learning environments.

These findings are only preliminary; however, it is arguable that the current gender disparity in this activity starts at a young age, when girls are less likely to participate in mountain biking than boys. This could also provide part of the explanation as to why females rate themselves at a lower ability level and are more likely to dislike bike maintenance—they may lack confidence in learning a new and "foreign" skill; one that males are often more familiar with. It is possible that encouraging more girls to engage in all aspects of mountain biking when they are younger may not only tackle the gender disparity, but also increase the proportion of female riders who feel confident and competent in their riding ability and enjoy all aspect of the sport. Further precise research is required to enable additional investigation.

Nature

Regular exercise is known to be integral to health and well-being, and outdoor environments are consistently found to be more therapeutic than indoor environments (Hug et al., 2009;

[1]https://www.cyclinguk.org/blog/victoria-hazael/day-women-bike.

TABLE 6B | Mountain Biking and well-being.

		Total		Downhill riders		Non-downhill riders		Male		Female		Younger riders (≤35)		Older riders (>35)	
		n = 1,484		*n* = 455		*n* = 1,030		*n* = 1,244		*n* = 205		*n* = 480		*n* = 991	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Participating in mountain biking makes me feel good about who I am	Agree	1,326	89.4	414	91.2	912	88.5	1,099	88.3	194	94.6	442	92.1	872	88
	Neutral	146	9.8	35	7.7	111	10.8	134	10.8	10	4.9	37	7.7	108	10.9
	Disagree	9	0.6	4	0.9	5	0.5	8	0.6	1	0.5	1	0.2	8	0.8
	Total	1,481	99.8	453	99.8	1,028	99.8	1,241	99.8	205	100	480	100	988	99.7
Mountain biking helps me to deal with negative thoughts or feelings	Agree	1,219	82.1	377	83	842	81.7	1,013	81.4	177	86.3	402	83.8	806	81.3
	Neutral	234	15.8	64	14.1	170	16.5	205	16.5	24	11.7	71	14.8	161	16.2
	Disagree	29	2	12	2.6	17	1.7	24	1.9	4	2	7	1.5	22	2.2
	Total	1,482	99.9	453	99.8	1,029	99.9	1,242	99.8	205	100	480	100	989	99.8
Mountain biking is something I do to de -stress	Agree	1,339	90.2	415	91.4	924	89.7	1,120	90	188	91.7	437	91	889	89.7
	Neutral	118	8	29	6.4	89	8.6	102	8.2	13	6.3	35	7.3	83	8.4
	Disagree	22	1.5	8	1.8	14	1.4	18	1.4	3	1.5	7	1.5	15	1.5
	Total	1,479	99.7	452	99.6	1,027	99.7	1,240	99.7	204	99.5	479	99.8	987	99.6
When I ride my everyday worries fade away	Agree	1,387	93.5	428	94.3	959	93.1	1,158	93.1	197	96.1	461	96	913	92.1
	Neutral	88	5.9	22	4.8	66	6.4	78	6.3	7	3.4	19	4	69	7
	Disagree	7	0.5	3	0.7	4	0.4	6	0.5	1	0.5	0	0	7	0.7
	Total	1,482	99.9	453	99.8	1,029	99.9	1,242	99.8	205	100	480	100	989	99.8
I would find it depressing if could no longer ride due to illness or injury	Agree	1,402	94.5	431	94.9	971	94.3	1,181	94.9	189	92.2	456	95	933	94.1
	Neutral	50	3.4	14	3.1	36	3.5	41	3.3	7	3.4	14	2.9	36	3.6
	Disagree	30	2	8	1.8	22	2.1	20	1.6	9	4.4	10	2.1	20	2
	Total	1,482	99.9	453	99.8	1,029	99.9	1,242	99.8	205	100	480	100	989	99.8

TABLE 6C | Active use of mountain biking as a coping strategy.

		Total		Downhill riders		Non-downhill riders		Male		Female		Younger riders (≤35)		Older riders (>35)	
		n = 1,484		*n* = 455		*n* = 1,030		*n* = 1,244		*n* = 205		*n* = 480		*n* = 991	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
I suffer from mild mental health problems (e.g., stress, anxiety, or depression) and use MTB as a coping strategy	Agree	502	33.8	173	38.1	329	31.9	393	31.6	94	45.9	185	38.5	315	31.8
	Neutral	269	18.1	87	19.2	182	17.7	235	18.9	30	14.6	90	18.8	177	17.9
	Disagree	702	47.3	191	42.1	511	49.6	606	48.7	80	39	203	42.3	490	49.4
	Total	1,473	99.3	451	99.3	1,022	99.2	1,234	99.2	204	99.5	478	99.6	982	99.1
I suffer from severe/enduring mental health problems and use MTB as a coping strategy	Agree	109	7.3	44	9.7	65	6.3	89	7.2	18	8.8	41	8.5	67	6.8
	Neutral	305	20.6	100	22	205	19.9	256	20.6	43	21	113	23.5	191	19.3
	Disagree	1,061	71.5	306	67.4	755	73.3	892	71.7	142	69.3	324	67.5	726	73.3
	Total	1,475	99.4	450	99.1	1,025	99.5	1,237	99.4	203	99	478	99.6	984	99.3

Ryan et al., 2010; Scheinfeld et al., 2011; Mitchell, 2013; Martyn and Brymer, 2016; Yeh et al., 2016). Evidence suggests that maintenance of a positive mood requires adherence to long term physical activity (Mead et al., 2009). The participants in our study were motivated to participate on a regular basis over a prolonged period with little variance across the subsamples; thus arguably increasing the likelihood of sustaining emotional balance. The participants, almost unanimously, loved being outdoors and recognized its therapeutic potential to deal with stress. This supports findings that the outdoor environment acts as a significant motivator for regular, sustained participation in sports such as mountain biking (International Mountain Biking Association, 2010; Taylor, 2010; Davidson and Stebbins, 2011; Lynch and Dibben, 2016; Moularde and Weaver, 2016). Our findings cannot definitively tell us whether participants would exercise as regularly (if at all) if they were not able to participate in mountain biking. Our data does show, however, that mountain biking encourages all riders to get outside and explore their local

countryside more; and this did not show any variability across any subsamples. It is arguable that these participants would not be accessing the outdoors as much were it not for their participation in mountain biking.

The feeling of connection with nature is thought to be of great benefit to human well-being (Martyn and Brymer, 2016). Our results confirm that mountain biking provides opportunities for participants to feel this connection, supporting Davidson and Stebbins (2011) assertion that it is common for adventure sport participants to talk about feeling that they are "part of nature" (p. 183). Downhill riders in Hagen's (2013) qualitative study did not mention any well-being benefits afforded by riding in wilderness environments; though they did talk about connections with specific trails or obstacles. In contrast, our study showed no meaningful variance in the responses from those who rode downhill compared to those who did not with regards to feeling an improved connection to nature through riding. Participants in Hagen's (2013) study were all elite riders, which may have influenced her results; and furthermore, many of the downhill riders in our study also rode cross-country and on trails.

Only a very small minority of participants indicated that they did not ride in bad weather. Exercising in changeable outdoor environments is thought to provide anxiolytic effects as participants become "more comfortable with uncomfortable somatic and sensory experiences," similar to the physical symptoms of anxiety (Lawton et al., 2017, p. 8). This is especially true of exercise in adverse or uncomfortable conditions (Anderson and Shivakumar, 2013). Countless mountain bikers may therefore be experiencing additional mental health benefits by riding in less favorable conditions. The majority of mountain bikers in our survey acknowledged that mountain biking maintained a sense of emotional balance: helping them to de-stress and deal with negative thoughts and everyday worries; and encouraging them to feel good about themselves. However, whether or not these concepts translate into an improved ability to deal with symptoms of anxiety in everyday life was not captured. Furthermore, the precise mechanisms by which mountain biking improves perceived well-being were not sufficiently measured, therefore we cannot say to what degree our findings are due to the environment within which mountain biking occurs or to something else integral to the activity.

Mental Health and Well-Being

Participants reported many positive mental health benefits directly linked to their participation in mountain biking, including an improved mood, a decrease in stress and worry, and increased self-esteem. It is vital to note that the well-being outcomes measured in this study showed minimal variability across all subsamples, despite the variability in engagement methods and characteristics of riders within the subsamples. This is supported, in part, by findings from Pretty et al. (2007), whereby the mood and self-esteem outcomes of participants of 10 different outdoor leisure activities did not differ according to type of activity, or its duration or intensity. Mountain biking is versatile, with a myriad of ways in which to participate. It could be surmised that mountain bikers are able to locate themselves within this activity and participate in a way which matches their motivations and character traits, thus allowing them to benefit equally.

Participation in high-risk sports can act as a means by which individuals manage their emotional life and alleviate negativity (Taylor, 2010; Brymer and Schweitzer, 2013). Indeed, our study illustrates that many mountain bikers believe that they would be depressed if they could no longer ride. This suggests that mountain biking plays a significant role in the maintenance of positive mental health and well-being for its participants, supporting findings by Cycling UK (2017). Willig (2008) paints a similar picture, whereby individuals experience their participation in high-risk sports as a fundamental need that helps them to function in everyday life—some participants went as far as to state that they would be using alcohol or drugs in order to meet their emotional needs were it not for extreme sports. Depression, the leading cause of ill health worldwide, increases the risk of substance misuse substantially (World Health Organization, 2018); clearly presenting far greater risks of injury and death than even the most extreme of sports.

One in three participants in our study stated they experience common mental health problems, with women being disproportionately affected, and use mountain biking as a coping strategy. This conforms to recent figures published by the World Health Organization (World Health Organization, 2018). Men are known to be less likely to both indicate that they have mental health problems and seek professional psychological help, unless they are very severely distressed (Mackenzie et al., 2006; World Health Organization, 2018). Unsustainable and damaging coping strategies, often leading to alcohol dependence and drug misuse, are more common for men (World Health Organization, 2018). Male mental ill-health, especially at the less severe end of the spectrum, may materialize in ways that do not fit as easily within conventional approaches to treatment. It is a crucial point that such a large proportion of our survey participants proactively use mountain biking as a coping strategy. Adding strength to this is that a slightly larger proportion of males compared with females claimed they would be depressed if they could no longer engage in mountain biking; a recognition that mountain biking could be acting as a substantial protective factor in their lives. Outdoor adventurous activities are likely to have lasting benefit to mental health (Brymer et al., 2010; Ryan et al., 2010; Mitchell, 2013; Martyn and Brymer, 2016; Yeh et al., 2016; Lawton et al., 2017). In the context of a society within which most people experiencing psychological disorders and/or emotional distress remain both undiagnosed and untreated (Mental Health Taskforce, 2016; World Health Organization, 2018), it is imperative that individuals, in particular those less likely to seek professional help, find ways to mediate and maintain their own mental health. The use of proactive and unconventional interventions, such as mountain biking, need careful consideration and further research.

LIMITATIONS

A proportion of the participants stated they like others to see them as adventurous people, resonating with Willig's (2008) insights into identity formation in extreme sports. This serves as

a warning for social desirability bias; however, due to the survey being online and anonymous the bias is likely to be limited. By exclusively recruiting online, self-selection bias is increased, and could be skewed toward those who participate regularly or have a disproportionate level of enthusiasm for the sport. There are also limitations associated with cross-sectional retrospective data, which relies on participant recall.

A non-standardized survey tool was used for data collection. Although this allowed an expansive range of data to be captured related specifically to mountain biking; it also restricted the possible rigor of well-being outcome measurements. Future research could utilize qualitative methodologies in order to capture and explore some of the subtleties highlighted within this study; or standardized measures such as the Benefits of Hiking Scale, adapted for use with mountain biking by Hill et al. (2017), or the self-esteem and psychological health measures used in Pretty et al's (2007) study. The development of Likert Scales as opposed to using single Likert items could further enhance the potential for stronger conclusions in future studies.

CONCLUSIONS AND FUTURE DIRECTIONS

Firstly, this study's findings, alongside other evidence, suggests that risk-taking behavior in this field does not necessarily have negative connotations. This study suggests that those who are more motivated by risk (in particular, younger, downhill riders) are also more likely to enjoy this aspect of the sport; and as such are also more inclined to mitigate against these risks by spending more time practicing the required skills to deal with those situations, and arguably being more committed to the sport (riding more often and in all weathers). Further qualitative research would better develop the subtleties discussed with regard to risk-taking attitudes and behaviors of mountain bikers implied within this study; however, our findings imply that the experience of risk can be positive and enjoyable, and may motivate participants to commit time and effort to master skills.

Secondly, our findings confirm that females are under-represented in mountain biking, though the majority of their experiences, motivations, preferences and perceived well-being outcomes vary very little when compared with males. In conjunction with existing literature, we suggest that in order to begin to address this disparity, women ought to be encouraged to be involved in all aspects of the sport from a younger age. This is important because a high percentage of the females in this study report that this activity helps them to regulate their mental health; and as such, it could be helping others. Rigorous and specific research is required in order to expand upon this recommendation.

Finally, these findings confirm that mountain bikers are not a homogeneous group; rather the population is composed of people who not only participate in this activity in many different ways, but also have different characteristics, motivations, preferences, habits and styles. The study did suggest that younger riders were slightly more likely to be drawn toward the "riskier" ways of participating in mountain biking, and were also more committed to the skills-based aspect of the sport; and that older riders who did not participate in downhill riding rode more casually. It is a tribute to the versatility and malleability of mountain biking that so many diverse participants are able to engage in ways which appear to suit them. Importantly, mountain bikers reported copious benefits to mental health and well-being related to their engagement, with minimal variability across all participants and irrespective of the confounding factors related to rider characteristics or engagement methods. A large proportion of the participants currently use mountain biking as a coping mechanism for their pre-existing mental health problems; and the majority use it as a way to deal with stress. As such, our findings provide insights that could inform future research, which could then encourage the development of outdoor adventure activities such as mountain biking as complementary mental health interventions; particularly for those who are less likely to access conventional therapies.

AUTHOR'S NOTE

LR was a member of the NIHR/HEE Integrated Clinical Academic Programme Internship Scheme.

AUTHOR CONTRIBUTIONS

LR: design, data collection, analysis, full write up; GJ: assistance with introduction, style and statistical analysis; RB: assistance with design, data collection, literature search, introduction, discussion, style.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2018.01642/full#supplementary-material

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Rock Climbing, Risk, and Recognition

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As extreme sports gain popularity – so does the public appreciation of such sports. Mass media are full of panegyric appraisals of these self-driven, individualistic athletes that dare to "live life to the fullest." Voluntarily seeking risks, in general, and in extreme sports specifically, is often understood in terms of individual traits or the unique, strong emotions such experiences give. In this article, we move beyond individualistic explanations of risk-taking that understand risk-taking as personal traits. Instead, we focus on processes of recognition based on group values. More specifically, based on autoethnography and interviews with elite climbers in Norway, we explore to what extent risk-taking is built into the value system of climbing, and to what degree risk-taking leads to peer-recognition and credibility within rock climbing communities. We find that there is a clear connection between risk-taking and recognition in the value system of climbing. As newcomers become part of the climbing culture they learn what has value and make these values part of their own intrinsic motivation. Hence, climbers develop what we call a risk-libido. However, the results show that there are no clear-cut demarcations between actions that lead to recognition, actions that go unnoticed and actions that lack credibility because they are seen as foolhardy. The fact that these boundaries are not clear, does not mean that boundaries do not exist. Based on our findings, we develop and propose a model of "Credibility-Zones" that establish the general principles of honor- and status distribution within rock-climbing in regard to risk-taking. Of particular interest is our finding that among the most respected, "consecrated," climbers, the "Credibility-Zone" is wider and less defined than for average climbers.

Keywords: risk-taking, Cred-Zone, extreme sport, recognition, Pierre Bourdieu, climbing

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INTRODUCTION

When climbers are forced to legitimize their risk-taking behavior, they will usually say something like "It's fun," "It gives me great experiences of and with nature," or "It's about mastering something difficult and potentially dangerous." A philosophically inclined climber might answer with a quote from the Norwegian existentialist and climber Peter Wessel Zapffe: "Mountaineering is meaningless as life itself—therefore its magic can never die" (Zapffe, 1969/2012, p. 93). Or maybe they have given up explaining altogether and just respond, "Because it's there." In this article, we will give this a little twist and state that climbers do not climb because the mountain "is there" but because other people "are there," that means that we will explore the social component of risk-taking behavior in regard to climbing.

Risk-taking behavior has puzzled researchers from various academic backgrounds for a long time. Considerable research has been conducted on themes such as risk-taking and personal psychological traits on the one hand and risk-taking and experiences, such as flow, on the other. However, little research has focused on the social psychological mechanisms behind risk-taking. To explain our approach to risk-taking, it is necessary to give a brief overview of the academic literature that describes and explains the phenomena of voluntary risk-taking. The different ways of understanding risk-taking, at least in regard to sports, can be broadly summarized with three main approaches: (1) the individualistic, (2) the "phenomenological," and (3) the sociological.

What we call the individualistic approach is characterized by the understanding of risk-taking as something deeply personal. According to this approach, the propensity, or should we say "need," to do dangerous things is deeply rooted in the individual. Some people are born to seek out dangerous situations. This might be because their genetic make-up makes them "high sensation seekers" or just because they are, for instance, type T personalities (e.g., Zuckerman, 1979, 2007; Farley, 1986; Breivik, 1996).

The "phenomenological" approach does not point at deeply rooted individual traits but at the deep emotions and experiences provided by involvement in sports that typically involve risk. "Phenomenological" is set in quotation marks here, because much of the literature we are aiming at is connected to Csikszentmihalyi's (1991) flow theory, which, even if it is sometimes referred to as phenomenology, does not entail a rigorous phenomenology in either the concept's philosophical or methodological sense. These theories focus on how actions that involve the right balance between challenge and skill are the source of emotions and feelings that are so satisfying that, to put it simply, no other explanation of why people do dangerous things is needed (Csikszentmihalyi, 1991; Jackson and Csikszentmihalyi, 1999).

The macro-oriented sociological approach seems to go in two directions, one compensation model and one adaptation model (Langseth, 2011). The compensation model understands participation in risk sports as a "safety valve" in a society that is overly concerned with safety. Risk sports, then, are a way of escaping a constraining, boring modernity. The adaptation model holds the opposite view, that increasing numbers of people turn to risk sports not because they are turning their backs on society but because the cultural norms of our modern society, the zeitgeist, demand that we live exiting, creative, autonomous, liberated lives. We ought to "seize the day"—and the day had better not be dull! According to the adaptation perspective, risk sports and their participants are not frowned upon; rather, the participants are a kind of cultural hero for our time. According to adaptationists, cultural imperatives in modernity push people toward risky sports.

The approaches above are certainly simplistically presented; there are more than three different ways to understand risk-taking. Nor are we suggesting that any of the above approaches are wrong or flawed. However, we need the above approaches to frame our own understanding of risk-taking. In this article, we argue that to understand "risk-libido," the driving force behind risk-taking, we should neither merely study individual traits and experiences nor focus solely on macro-level social changes, but should also include social processes that make risk-taking logical and rational at a group (meso) level. Several studies have emphasized the importance of studying the context wherein risk rationalities develop (Hunt, 1995; Booth, 2003; Donnelly, 2004; Laurendeau, 2006; Beedie, 2007; Fletcher, 2008; Langseth, 2012, 2016). Based on the insight from these studies, this article focuses on the relational aspects of human behavior. That means that we are not studying individual climbers' motivations and experiences but, rather, how established sets of values in the climbing community influence the individual climber. In our understanding, then, to study risk-taking in climbing, we must focus on what goes on between people in a group and not what goes on "inside" each individual. Booth and Thorpe (2007, p. 183) claim that in risk sports cultures, ". . .risk constitutes challenges, and meeting these challenges earn members—predominantly young men—rewards (e.g., peer recognition and prestige)." Similarly, Hunt, in a study of scuba divers, found that the divers ". . .are exposed to a competitive, informal system that places high status on the ability to dive deep-water wrecks and gather artifacts, both of which involve considerable risk" (Hunt, 1995, p. 445). In his study of base-jumpers, Langseth (2012, 2016) found that base-jumpers denied that risk-taking held any value in their culture, claiming that they base-jumped solely for their own sakes. Still, Langseth (2012, 2016) maintained that risk-taking was cultivated by subtle means. Langseth argues that risk-taking could be seen as a form of symbolic capital that gives rise to status and power hierarchies within the base-jumping community. The question, then, is whether we can find the same mechanisms within rock climbing. Robinson (2008, p. 149) states that to a degree, climbers take risks to achieve sporting success. In this study, we will explore and develop risk-taking along the same lines that Langseth (2012, 2016) did for base-jumpers. We will query into how group-level processes facilitate risk-taking by following three research questions. (1) What holds value in the field of rock climbing? (2) Is risk-taking a value in the climbing community? (3) What are the boundaries between actions that gain a climber recognition and credibility and actions that are deemed foolhardy?

The aim of the study is to get a better grasp of risk-taking by accounting for how subcultural values influences the actor. By doing this, we want to highlight the social aspects of risk taking. We are not saying that individual propensities and experiences are not important when it comes to understanding motives for risky actions. However, the social facets of risk taking is understudied. Hence, the importance of this study is that it expands the understanding of voluntary risk taking in sports.

MATERIALS AND METHODS

Methodologically, this article relies on two sources: qualitative interviews and autoethnography. To establish the values, hierarchies, and value hierarchies connected to risk-taking within the Norwegian climbing community, this study primarily

depends on the authors' own experiences in rock-climbing communities. One of the authors has been part of the Norwegian climbing community as both a climber and instructor since the early 1990s. The other author has been climbing since the mid-2000s and is currently qualifying as an international climbing guide through IFMGA (International Federation of Mountain Guides Associations). Even though our involvement with rock climbing does not qualify as systematic ethnography in the sense of rigorous participant observation, we still think that our participation puts us in a good position to outline the values that climbers adhere to. This places this project within the form of autoethnography that Anderson (2006) calls "opportunistic CMR" (complete member researcher), in which membership within a culture precedes the decision to do research on it. According to Ellis and Bochner (2006, p. 445) the term "autoethnography" should be reserved for research that "expresses fieldwork evocatively." We do not agree. We would rather, in line with Anderson (2006), argue that autoethnography (and ethnography) should strive toward creating a theoretical understanding of the studied phenomena. The strength of autoethnography, as we see it, is that the researchers can have a full, embodied understanding of the culture under scrutiny while at the same time maintaining a critical distance from the participants' meanings and statements about their motives, values, and goals.

Following Thorpe (2010), understanding participants' world view and at the same time being critically distanced makes ethnography a hard task to master. The problem with "going native," where the researcher becomes so engrossed that the distance from the researched culture disappears, is well described in ethnographic literature (e.g., Hammersley and Atkinson, 1996; Fangen, 2004). One could argue that the "going native" issue is even more problematic within autoethnography, where the researcher's subjectivism and personal involvement is often thought to influence the outcome of the research. Hayano (1979, p. 101) points out that this is not necessarily a problem but is, rather, an asset that contributes to a deeper understanding. The risk aspect of climbing and its connectedness to credibility is not often discussed openly in the climbing culture. Our theme must be said to have a somewhat disguised character. Every climber tacitly knows that there is a connection between risk-taking and status, but a researcher without involvement with the climbing culture might very well run the risk of taking climbers' statements at face value. So when climbers (or other extreme sports participants) state, "We don't care about status," "We do this solely for ourselves," "The winner of the day is the guy with the biggest smile," "Risk is something we avoid," and so forth, researchers without climbing experience might end up taking these narratives as the truth. In other words, we argue that our involvement with climbing makes it possible for us to be more critical and more distanced than researchers who have not been part of the climbing culture. Our participation in the climbing culture makes it possible for us to recognize learned figures of speech—ways of speaking about motivation and so on that climbers learn as they are socialized into the climbing culture, ways of speaking that conceal from the speakers the real processes behind their actions. For instance, many climbers would state that rock climbing is an individualistic endeavor and that there are no status hierarchies in the sport. However, as climbers we know that there are distinct status hierarchies concerning who are considered good or solid climbers and that there are certain climbers and climbing styles that are held in high regard. This means, as mentioned, that the participants' statements cannot be taken at face value. So when climbers talk about risk, risk-taking, and risk avoidance, we do not take these proclamations as the truth about what these themes mean for climbers. Rather, we take their statements as expressions of ways in which they have learned to talk about these themes within the climbing culture and the legitimate ways of speaking within the culture. In our view, the advantage of autoethnography is not that it makes "sensitive" presentations of the participants' world view possible but rather, that it makes it possible to understand and at the same time be highly distanced from these world views. Being "indigenous" and being researchers, we think, puts us in a privileged position. The French sociologist Pierre Bourdieu (1999, p. 198) states:

> *Social games are hard to describe in their double truth. Those who are captured by them barely have any interest in objectifying the game, and those who are not are often too poorly positioned to explore and experience what cannot be learned and understood without participating in the game.* (Our translation)

In our understanding, autoethnography, embodied in the researcher–climber, entails just this—the opportunity to understand the double truth of the climbing "game," on the one hand understanding climbers and motives and on the other hand having the possibility of objectifying the same motives and feelings, tracing the discourses that have produced them. This means that we must somehow break with the agents' own explanations. In Bourdieu's words, we must perform an epistemological break. According to Bourdieu et al. (1991), it is important in empirical research to question and break with established truths and to reestablish actors' statements within a theoretical framework. In practice, that means reinterpreting the actors' actions and explanations in the light of the climbing field and its value system. This means that we, as researchers, and climbers will probably have diverging views on the truth about risk-taking in climbing. Our analytical understanding of climbers' reality does not necessarily correspond to their own understanding.

In addition to autoethnography, and to avoid our own experiences from the climbing field being the only source of data, semi-structured interviews (Kvale and Brinkmann, 2009) with five elite Norwegian climbers were conducted to acquire information about climbers' personal narratives of risk-taking. The interviews were conducted using an interview guide with certain predefined themes while at the same time being open enough to allow for follow-up questions and an elaboration of relevant themes that came up during the interviews. The predefined main themes in the interview guide were: climbing background, Motivation for climbing, socialization into the climbing culture, the climbers relationship to own risk taking, the climbers understanding of other climbers' risk taking and their

understanding of hierarchies within the climbing community. All interviews were fully transcribed. The interviewees were selected based on certain criteria. We sought climbers with a strong connection to and high standing within the Norwegian field of climbing. We also wanted climbers who were heavily involved with ice climbing, alpine climbing, and/or climbing with natural protection. The reason for this is that the risk involved in these forms of climbing is more prominent than in more popular forms of climbing, such as bouldering or sports climbing (Schöffl et al., 2010). We also sought interviewees who were well known in the Norwegian climbing community, on the assumption that well-known climbers are looked up to by other climbers, and hence, they have some kind of power of definition. To find the right climbers, we went through all volumes of the Norwegian climbing magazines *Norsk Klatring*[1] (Norwegian Climbing) and *Tidsskrift for Norsk Alpinklatring*[2] (Journal of Norwegian Alpine Climbing) from 2008 until 2014 and contacted some of the most profiled climbers. We ended up with five climbers who are all well-known within the Norwegian climbing community. The youngest was in his early twenties and the oldest in his late forties. All of them were men. We do not have data on what percent of the Norwegian climbing population is female, but data from Great Britain suggests that 70% of British climbers are men (Llewellyn et al., 2008). It is our impression that even fewer women participate in the form of climbing activities that we sought after. A few Norwegian women fitted the types of climbers we were looking for, but unfortunately, we did not succeed in getting interview appointments with them. Former research in comparable activities reveals similar difficulties (Robinson, 1985; Slanger and Rudestam, 1997; Holland-Smith and Olivier, 2013). How the gender imbalance influences our result is hard to tell. Men are overrepresented in all outdoor life accidents in Norway (Horgen, 2013), which might indicate gender differences in behavior patterns as well as different forms of risk logics.

When analyzing the interviews, we held in mind Bourdieu's view that an epistemology of continuity is mistaken (Bourdieu et al., 1991). Following Bourdieu, a true (social) science cannot be satisfied with presenting actors' self-understanding but must grasp both the structure that influences actions and the structures behind the naïve representations of action. Bourdieu particularly criticizes phenomenological approaches for being naïve (Bourdieu et al., 1991); first of all, actors' *experiences* are constructed from historical and social circumstances. Secondly, when actors are asked to talk about (self-interpret) their actions and experiences, the researcher will get answers that are historical and that are social constructions at a second degree, in other words, ways of speaking about things that are within a social structure. The researcher's interpretation, then, will be a third-degree interpretation, far from the phenomenological "Sache selbsts." Hence, in analyzing the transcribed material, our approach was what Kvale and Brinkmann (2009) call a *theoretically informed reading*. This involves reading through and analyzing the material with certain theoretical preferences in mind. The material has thereby undergone a type of meaning interpretation that seeks to uncover structures and meaning dimensions rather than what is directly said in the interviews. More inductively inclined researchers often criticize such theoretically informed analysis. It is often pointed out that the researcher will find nothing more than he or she knew before and will find only data that "fits" the theory. This might be a problem. However, as we see it, the presence of data that supports the theoretical prenotions simply indicates that the relationships we are looking for exist.

[1] Six issues per year.

[2] One issue per year.

THEORETICAL APPROACH

To understand how actors develop a desire to engage in risky actions, this article builds on the theories of Pierre Bourdieu (1977, 1993; 1999, 2004) and, to a certain extent, George Herbert Mead (1934). Bourdieu's theories have been widely used to describe the relationship between social background and participation in sports (Laberge and Kay, 2002). However, in this article, we use Bourdieu in another way. We are interested in the cultural learning that takes place within the frames of rock climbing and in how this is connected to risk-taking. The connection between risk-taking and cultural learning in relation to windsurfing is made clear by Dant and Wheaton (2007): ". . .the physical capital of windsurfing, while it may give the sport its distinctive and extreme character, only becomes meaningful to participants, through the social process of a subculture (p. 11). So to understand risk-taking, we must look at how it is connected to the value system of particular sports subcultures.

Following Bourdieu, to understand how people act, we must understand the relation between social fields, forms of capital, and agents' habitus. Even though we are not going to use the concept of habitus in this article, we have to say a few words about it to make Bourdieu's theories coherent. Habitus can be seen as each individual's "frame of action," bodily ingrained experiences, and memories that determine how the person acts and understands the world. Habitus works below the threshold of language and makes the world appear in certain ways. The individual's social background as well as other social groups that he or she has belonged to give roots to lasting habits and dispositions that determine how we think, feel, act, and dream about achieving (Bourdieu, 1977, 2004). Since every person has an individual biography, every habitus is unique. Still, habitus can be understood at a group level. Without delving into a discussion on philosophical agency, the point here is not that agents do not have some form of individual will but rather that they are, in one way or another, connected to and influenced by social relations. The climbers interviewed for this project have been through years-long socialization processes that produced in them a similar habitus; to some extent at least, they share the same values, dreams, and goals. It is important to note that habitus is in continual change; even though it might be resilient, it is not set once and for all after childhood but continues to evolve as persons get involved in new social fields.

In Bourdieu's understanding, fields are social arenas where agents fight over symbolic or material interests that are common to them and only to them (Broady, 1991). Every field has its

own norms and logic that agents must incorporate to be able to "play the game." Bourdieu often uses the "game" metaphor to emphasize the element of competition, the presence of indisputable rules (which Bourdieu calls "doxa"), specific forms of investment, and rewards in every field (Bourdieu and Waquant, 1992, pp. 97–98). A central point is that the agents' conscious knowledge of the rules of the game is minimal. The rules are taken for granted or seen as "natural." The "naturalization" of these rules is what makes an investment in a field meaningful, at least in such a way that the meaningfulness of participating in a certain activity is not questioned. However, defining climbing as a field is not unproblematic. The concept was originally used to describe rather broad societal areas such as the political field or the field of literature. Compared to these fields, climbing is a rather narrow field. Still, it is not hard to legitimize the choice to see climbing as a field. Climbers share a common logic and a set of values that is generally tacitly accepted by most climbers. The practice around free ascents, where the climber must adhere to strict rules before being able to claim that she or he has climbed the route, illustrates this. Even though such rules are mostly taken for granted, they are a result of power struggles within the climbing field. Continuous power struggles have formed and are forming the field of climbing, for example, with respect to what is seen as "good style" (more about that later). The point is that as an aspiring climber is socialized and becomes a part of the climbing culture, the person also makes the rules and values that exist in the field a part of her or his own way of thinking and behaving, and the objective values of the field become internalized in each climber. Following Bourdieu (1993), determining what a field is, is the same as determining the forms of capital within a social arena.

Bourdieu is probably most known for the concept of cultural capital, a concept that highlights how knowledge of traditional "high culture" is related to power in a country such as France. In this article, we rely on his general concept of symbolic capital, which involves values that give recognition and prestige within a field. Symbolic capital is always related to a field, because without agents that understand an action, an artifact, or something similar as valuable, it would be worthless (Broady, 1991). A specific form of symbolic capital, let's say economic capital, might very well be valued in several fields, but it can never be independent from fields. Money has no value in societies that do not use a monetary system. Training hard to free climb a certain climbing route would be worthless if not for the climbing field and the agents who have internalized the values of the climbing field, who recognize the activity of climbing as meaningful. To climb a long, demanding, difficult big wall route is only meaningful if there are other people who recognize the act as meaningful. Beal and Wilson (2004, p. 46) argue that extreme sports place risk-taking at center stage and that these activities "rely on risk and difficulty to determine status." In this article, we explore whether and to what extent risk-taking can be seen as a form of symbolic capital within the field of climbing.

Bourdieu is often criticized for not explaining and not emphasizing how the actual process of socialization works. Several of our interviewees started climbing as adults, so perspectives on how they acquire the mental structures of the climbing field need a few more words. The symbolic interactionist George Herbert Mead's theories about the development of the social self might suffice. According to Mead (1934), it is through interaction with other people that we develop a "self." Mead's self is a self that has learned and incorporated values and ideas from interaction with other people; it is a social self. The way we act and think is influenced by the expectations of other people. However, what we think is expected from us is dependent upon the specific situation. In close relation to Mead's theories—even though it was not developed by him—is the concept of significant others. The concept describes persons in our primary network who are of special importance to us. This perspective is relevant to us, because it contributes a theoretical perspective on how climbers mirror themselves in other people's reaction to their own actions and also why the meaning bestowed by some people might mean more than that bestowed by others. As the Norwegian climbing historian Geir Grimeland (2004, p. 236) points out, "It is the connoisseur's recognizing nod which matters in the social life of the climber." In other words, credibility in climbing is often allocated by subtle means rather than in clearly specified ways. That is, the rules are quite clear and specific, but they are also tacit, more often than not.

RESULTS AND DISCUSSION

Risk-Taking and the Value System of Climbing

When climbers and other risk sports participants are asked about risk-taking, they are usually quick to state that they take all precautions to make the activity as safe as possible and that risk taking is not part of their motivation (see Brymer, 2010; Frühauf et al., 2017). Langseth (2012) found that base-jumpers often stated that they do not care about recognition and that they participate in the sport just because it is what they themselves want. Being part of the Norwegian climbing community, we have often heard similar utterances from climbers. But can we trust the explanations the climbers and other risk sport participants give? Not necessarily. First of all, climbers seldom have an articulate understanding of the values, rules, and logic of the climbing subculture. Secondly, when asked about motivation, they will give answers in a language that is shaped within the same subculture; they speak about motivation for climbing in the ways they have learned to talk about it within the climbing culture. That means that they will answer in the ways that are legitimate for a climber to speak about motivation. At the same time that the neophyte climber learns a new vocabulary for speaking about rock types, moves, and climbing gear, they also learn to speak about experiences and motivation. So when a researcher asks a climber about why they climb, their relation to risk-taking, etc., the answers are mostly prefabricated readymades. Thus, to truly understand the mechanisms behind risk-taking, we must look beyond the individual climbers' statements. In society in general, but even more so in extreme sports, it is the individualistic explanations of action that are legitimate. "Intrinsic motivation," where the agent is "engaging in an activity for itself and for the pleasure and satisfaction derived from participation" (Vallerand,

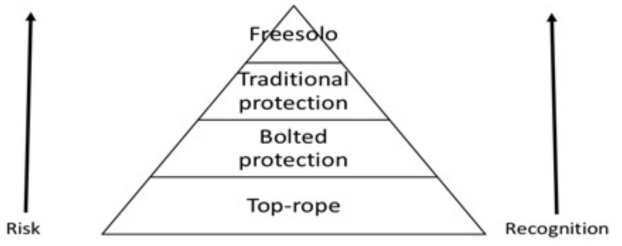

FIGURE 1 | Style distinctions in free climbing.

2004, p. 427), seems to be the only legitimate motive. A climber accepting that recognition is a driving force behind her or his action would be accepting the motivation does not come from "within." Still, from Mead to modern neuroscience, we know that human beings are not autonomous entities—sociality is a basic human feature. We get our personal values and emotions by mirroring ourselves in other people (van Kleef et al., 2016). We learn to know ourselves by the feedback we get from our peers. Recognition, according to Bourdieu, is a driving force in human beings' desires (Crossley, 2001). Thus, the values in a field – what gives recognition in a field – are connected to the individual actors' motives. However, what provides recognition will vary from culture to culture, between social classes, and from subculture to subculture. Before we can say anything about the individual climbers' motives in undertaking dangerous endeavors, we must lay out the value system of climbing and study the role that risk-taking plays within this system.

A novice climber will quickly learn the style hierarchy of climbing and that often in the climbing field, how something is done is considered more important than what is done. A climber's approach, tactics, and choice of equipment on a climb are some of the factors determining what is often referred to as "style." Beginners attending a typical 2-day introductory climbing course, which both authors have held multiple times over several years, are being taught early the all-important difference between "top roping" and "leading" a route. "Top roping," with the rope fixed from above, is the safer, less committed way of climbing, whereas "leading" involves bringing the rope from the ground and clipping protection as you progress up the route, risking longer falls. The novice will learn that top roping is not considered a valid ascent. This means that already, from the first day of a climbing course, the novice learns that the riskier way of climbing holds higher value. The beginner will also learn that the chosen method of protection is of importance. Placing your own gear is considered far better than relying on pre-placed bolts. And climbing a poorly protected route brings more recognition than climbing a well-protected route of the same difficulty.

The greatest and most recognized style of all, however, is using no ropes or protection gear whatsoever. American climber Alex Honnold's free solo ascent of El Capitan in Yosemite in 2017 is a fine example of the massive credibility and public appeal this can generate. Most climbers would agree with this style hierarchy of free climbing, even though they are not involved in the activities at the top, and this is the same kind of hierarchy you will find in other branches of climbing. In alpine climbing, the so-called "alpine style," where the climbers carry all their gear to the top in one push, is considered better the "capsule style" and "siege tactics," which are, again, considered a better style than that of commercial expedition climbing. These styles are all values held by the climbing community, and can be seen as forms of symbolic capital. The wily thing about these hierarchies is that the actions at the top not only entail more recognition but are also more dangerous. The logic that the beginner quickly learns is that the more risk is involved, the more recognition and credibility a climber will get. This connection between risk and recognition is not usually directly spoken about and climbers are not necessarily aware of the connection between risk and recognition. That risk-taking holds value is hidden in terms such as "bold" climbing and "style." Now, we are not saying that risk-taking is the only way to achieve status within climbing. There is no doubt that a sport climber such as Chris Sharma, mostly known for climbing hard but rather safe routes, has high status within the climbing community. Certainly, there are many ways for climbers to climb the hierarchy of climbing. But still, the risk-recognition nexus is taught under the disguise of "style" and "ethics" in climbing courses and introduction books (see for example Fyffe and Peter, 1990) (**Figure 1**). And as the novice becomes part of the climbing community, the risk-recognition logic is subtly communicated through rumors about climber X, who climbed that big wall route unroped, and climber Y, who only placed four pieces of protection on a hard pitch—conversations between friends around the campfire, which communicate values and convey the value of risk. Consider this text message that one of the authors received a while back: "Did a first ascent at Dale today. The route was exciting. . ." There is nothing extraordinary about this text message, but it says something important about the value logic of climbing. Let's say the route was a French grade 7b and was naturally protected. That would give the climber recognition and credibility, or "cred" as we call it in order to stay more in touch with the language climbers use. The extra information that the route was exciting probably meant that it was poorly protected. The first ascensionist can thereby cash in even more cred. Throughout the disciplines of climbing, from small boulders to the tallest mountains on Earth, the logic of risk resulting in higher recognition is consistent, even though climbers are not usually consciously aware of this connection. We say "not usually," because they might very well be. One of our informants, "Trym," says:

> *If you look at me as a sports climber that is not such a good sports climber anymore and doesn't send hard routes anymore. . . (I) have to, in a way, seek out the dangerous routes to get recognition in the community.*

Risk-taking can thereby be seen as a field-specific form of what Bourdieu calls symbolic capital, a form of capital that leads to or can lead to increased status within the climbing field. The "risk capital" can, in some (rare) cases, even be converted into economic capital. Consider the American climber Kevin Jorgeson. When he came to fame in the climbing world, he was a boulderer. However, at the time he became well-known, he was

not among the absolute top boulderers in the world. Rather, he became famous for doing "high-ball" boulder problems, boulder problems that top out so high above the ground that a fall would be dangerous. He was soon sponsored by Adidas and Duracell. This shows how risk-taking as a form of symbolic capital can be converted to economic capital.

There are elements of risk in most sports and outdoor activities. The question is whether or not risk is seen as problematic. The central point is that as people are socialized into the climbing culture, they internalize the field-specific values of that climbing culture. They learn "the rules of the game," and slowly these rules become natural and unquestioned, to such an extent that they are seen as naturally given. The climbers start thinking that it is just natural that leading gives more cred than top-roping and that leading a poorly protected route is better than leading a well-protected one. They develop what Bourdieu (1996) calls a "sense of the game," which means that the climbers become mentally structured in accordance with the logic of the game and forget that these rules are arbitrary. This gives them the feeling that the game is worth playing and worth investing in—and also that taking risks is valuable, because it is part of the game's rules that risk-taking provides credibility. The arbitrariness of such rules is described by Bourdieu in this way:

> *. . .What is at stake only exists for those who are involved in the game and are disposed to acknowledge the stakes, are ready to die for it—for something that seems entirely without interest from the perspective of those who are not involved in the game. . .*(Bourdieu, 1996, p. 134) [our translation].

Here, Bourdieu talks about general investments in all fields. But for climbers, being "ready to die" for something that seems worthless to outsiders is not a metaphor. The point is that even though the actions that climbers (and other extreme sports athletes) perform might seem spectacular, the mechanisms behind them are highly ordinary, involving learning and internalizing the values of a specific field or culture. The difference between climbing and other social games, let's say stamp collecting, is that the internalized values are (at least partly) connected to risk and that they thereby develop what we might call a risk libido.

The "Cred-Zone"

Now, is it all about risk, then? Does taking risks automatically entail a heightened status within the climbing community? Obviously, it is not that easy. If it were, any hazardous climber could attain instant legend status if he or she managed to stay alive for some time. Of course, there is more to this, and there are mechanisms to keep climbers from progressing too quickly in this field. Our experience from the field and interviews shows that there are a number of criteria that need to be fulfilled for risky behavior to receive credibility within the field.

Firstly, it has to be the right kind of risk. Voluntarily seeking out and climbing in avalanche terrain or ice climbing on poor ice because of the increased risk involved would not bring the climber recognition. The risk must be relevant, which means that it must be a form of risk that can be managed. Also, risking one's life by purposefully placing bad protection or rigging a poor belay, although this would significantly increase the risk of what you were doing, would not increase your accumulation of symbolic capital. On the other hand, keeping a cool head while climbing a hard, poorly protected pitch, an action central in the climbing game, would likely give a climber status.

Secondly, and more importantly, having a margin of error seems to be important for a climb to be given recognition and. As one of our informants, "Rolf," says:

> *. . .The important thing for me is that things are done in good style. Meaning that a climb is done in the way I think it should be done . . . in style and with margins. If you see that you don't have margins, you should go back down.*

The quote reveals that there are boundaries to the risk-recognition logic. This means that a climber must have margins in terms of a skill set and experience level that correlate to the climbing task at hand. If risk-taking is seen as being too much a game of chance, it seems like recognition is hard to attain. Margin is valued to the extent that our responders often expressed the idea that margin was synonymous with good climbing style. This trait was also previously documented by West and Allin (2010). It means that the skill level of the climber is important in the process of allocating status and prestige within climbing. For a climber to gain credibility in relation to risk, there must be the right combination of skill and risk involved. When talking about a friend of his that had just climbed a hard, scarcely protected route, "Trym" said:

> *You know, climbing that route is sick (. . .), but then I think that if he feels strong enough to climb it, then I actually thinks it is ok.*

The logic here seems to be that *to feel strong* indicates that a climber has margins enough on a route to get credibility for climbing it. Even though the quote reveals that "margins" is highly individualized, it still means that there are some kind of boundaries between actions that are deemed credible and not, even if these boundaries are blurred. The link between skillset, risk and recognition has lead us to develop a generalized "Credibility-Zone" model (**Figure 2**). The model is inspired by Csikszentmihalyi's "flow channel," where the feeling of flow is dependent upon the right degree of challenge on one side and the skill level of the performer on the other side (1992). Our model is what we might call a sociological ideal type (Weber, 1978). That is, it is a simplification where typical traits of a social phenomenon are highlighted.

The model simply shows that to get "cred" for an action, you must have the right balance of risk-taking and skills. A beginner taking on a hard, bold route would usually not get recognition. This action would instead be deemed foolhardy. The same goes for experienced climbers. When talking about alpine climbing in alpine style, one of the informants, "Jarle" says:

> *There has been a lot of pushing it in Alaska and Patagonia that has been, well. . . where they have pushed it far. (. . .) We have discussed a couple of the ascents. Ascents that has been successful and has been given a lot of recognition, but I,*

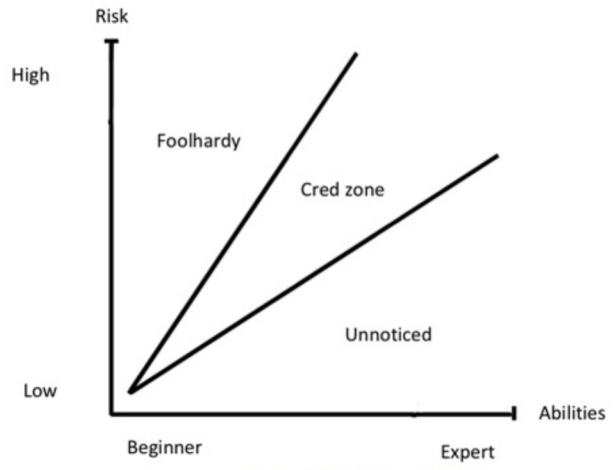

FIGURE 2 | Cred-Zone model.

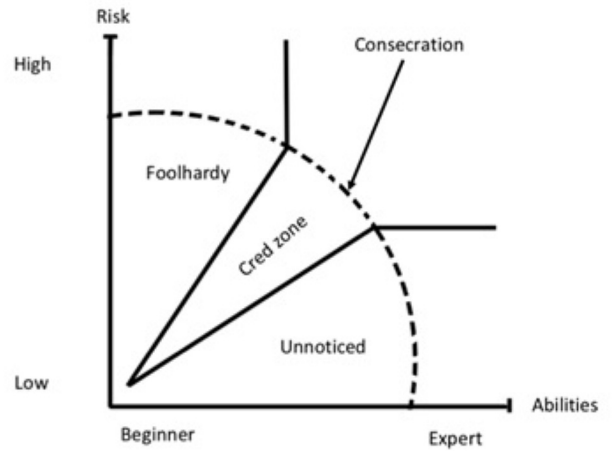

FIGURE 3 | Cred-Zone and consecration.

and many others think that they have taken to many chances to achieve it. (. . .) I think there is a delicate balance, (. . .) there are things that are done in the bigger mountain ranges in very light styles. . . (. . .) it is not everything done that I think is cool. . .when you get a feeling that they took a lot of chances and pushed it too far. . .I don't like that. . .when it is coincidence that determines if people survive. . .

The quote indicates that "pushing it to far," even if the ascent is successful, does not necessarily give "cred." The quote also reveals, as mentioned, that these boundaries are blurred, some climbers would give recognition and some would deem it foolhardy. The same blurred boundaries can be found in freeride skiing for instance. In 2006, Canadian skier Jamie Pierre set a new world record when he dropped an 82 m cliff. He landed on his head, but survived. In the discussion board of Norwegian skiing magazine "Fri Flyt" some commentators thought that this was "awesome," while others saw this as an stupid act that should not be given any recognition[3]. Again, this means that there are no clear-cut line between risky acts that are given recognition and those deemed foolhardy, but that does not mean that there are no boundaries.

On the other side of our model is actions that does not get recognition because the acts are too quotidian. An experienced climber, climbing an easy, safe route, would not get much cred because the action would likely go unnoticed. For an experienced climber, climbing a four pitch well protected 5.10 would not raise his or her status. In other words, climbing a safe, easy route, would not earn an accomplished climber (more) symbolic capital than what she or he has from before. For a relatively new climber, however, climbing the same route would give credibility. Over the course of our work, we realized that some climbers' achievements were not met with the same criticism and skeptical evaluation of their efforts as those of other climbers were. There was a clear pattern where more experienced climbers were enjoying the benefit of the doubt to a far greater extent than less experienced ones. One informant, "Sander," said that

There is a quite definite borderline between experienced and inexperienced climbers. When you have passed that line it is more accepted that you take calculated risks.

Therefore, the Cred-Zone in **Figure 2** is shaped like a funnel. In general, beginners seems to have fewer opportunities to earn cred; they have not yet invested enough in the field. On the other hand, experienced climbers seems to have more "slack" regarding what is deemed foolhardy or not. In the quote from "Trym" above an experienced climber is given cred because "*he feels strong enough.*" Our experience from the climbing field is that beginners are not given the same leeway when it comes to what gives cred. This, however, is an assertion that needs more empirical data before anything definite can be said about the shape of the Cred-Zone.

There also seems to be a line between experienced climbers and climbers that almost have a "hallowed" status that expands the boundaries for what is given cred. When talking about one of the top Norwegian climbers known for his ascents in the big wall Troll Wall in Norway, "Ola" said:

By climbing Troll Wall that many times in a row there is a clear increased risk for something to happen (. . .). I absolutely think that it is really cool that he is pushing it.

In Bourdieusian terms, we can say that some climbers might be considered "consecrated" (Bourdieu, 2004). That means that they are not just seen as experienced climbers, but they also achieve an almost sanctified insider status where their actions cease to be scrutinized in a critical manner. When talking about a climber who had just done a first free ascent of a scarcely protected route at Troll Wall, "Rolf" was very impressed and said:

It is obvious that what NN is doing, performance wise, is at a very high level. I have no idea about what style he is doing it

[3]https://www.friflyt.no/Ski/Jamie-Pierre-med-ny-verdensrekord-82-meter/Diskusjon-av-artikkel-Jamie-Pierre-med-ny-verdensrekord-82-meter

in, in regard to risk. I just see that he is taking things a step further, (. . .) but I have no idea about how he does it.

So, for this highly regarded climber the previous mentioned importance of "style" is not longer important. He still get cred, even though "Rolf" says he no idea about how the route was climbed. Exactly where the line between the consecrated and the unconsecrated is drawn is not easy to say, but it has to do with the accumulation of symbolic capital. In free climbing, it might be climbing a certain grade, whereas in alpine climbing, where the difficulties are more complex, having climbed certain routes might symbolize this transition. The interesting thing for us was that this led us to a slight change to the general Cred-Zone model. As shown in **Figure 3**, the Cred-Zone expands after consecration. That means that after consecration, it is easier to gain credibility, as an act is not seen as foolhardy by the same criteria as for other experienced climbers.

CONCLUSION

A common objection from climber friends when we talk about this project is that their motives for climbing have nothing to do with recognition or status. "It's all about having the feeling of mastering something; mastering something difficult is what gives us good experiences, which also means mastering stuff that is a bit scary and dangerous," they typically say. We agree. But what is it that climbers wish to master? What they wish to master is not something they themselves have defined. Climbing is not idiosyncratic. Rather, what climbers strive for, the routes they have a burning inner desire to fulfill, the mountain they want to summit because it is there, the lovely feeling of pulling off that move or placing that perfect cam—it all stems from their relation to the subculture of climbing. The central point is that what has value in the subculture of climbing is made personal; the values are internalized and made the climber's own values. This means that what is experienced as intrinsic motivation is connected to the recognized values in the climbing field or subculture. In other words, internal motivation is external, or has been external, in the sense that they stem from values that existed within the climbing culture prior to the individual climber entering it. This does not mean that climbers consciously act to get attention and recognition. Some do, of course; the use of recognition technology like Instagram or Facebook leaves no doubt about that. However, our point is that as climbers are socialized into the climbing culture, the values of this culture become part of their own inner life. What holds value and gives recognition within the climbing culture and becomes part of the individual climbers' own goals and dreams. From this perspective, climbers strive after what gives recognition, even though no one else would even know that they have climbed something recognizable.

The contribution of this article has been to establish the often-overlooked relationship between risk and recognition in climbing. By not taking climbers' statements at face value but instead highlighting the style hierarchies of climbing, we have argued that climbers develop a risk libido, a drive toward risk-taking, as part of being immersed in the climbing community. Yet we have also pointed out that risk, recognition, and status are not solely about doing dangerous climbs. To cash in on the symbolic capital that risk-taking is, certain considerations must be taken into account. An act deemed foolhardy by other climbers will not grant any status. The climber must show that they are in control and have margins on what they are doing. They must also show that there is correspondence between their skills and the risk they are taking. On the other side, doing a climb that is considered too easy or safe for skilled climber would not bring recognition either. Thus, in conclusion, to climb the hierarchy of climbing, you need balance—an embodied kind of balance that only a fine-tuned sense of the climbing game can give.

An interesting task for future research would be to test and further develop the Cred-Zone model in relation to other extreme sports. The model should also be tested by quantitative research, that could more clearly and precisely draw the lines between what is recognized and what is deemed foolhardy in an extreme sport culture.

ETHICS STATEMENT

This study was carried out in accordance to the requirements of NESH, the Norwegian National Committee for research in the Social Sciences and the Humanities. All participants received written information concerning informed consent before agreeing to be interviewed.

AUTHOR CONTRIBUTIONS

Both authors have made substantial contribution to the work and approved it for publication.

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Differentiating Identities Within an Extreme Sport: A Case Study of Mountain Biking Print Advertisements

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The work of McEwan (2016) has questioned the assumed homogeneity of mountain biking in terms of culture and sporting values, leading to the suggestion that there may be differing patterns of identity within the various formats of the sport. This is also supported by McEwan and Weston (2017) findings, which advanced knowledge of the mountain biking industry by defining the differing pluralized segments within the market and highlighting their hierarchical nature in relation to the cost of products. This therefore leads to a question over whether differing markets are reflected in differing identities among varying consumer groups within the sport of mountain biking. Thus, this study sought to establish what these identity characteristics are through an analysis of a sample of mountain biking magazine advertisements (*N = 568*). The analysis was conducted using a sequential Ethnographic Content Analysis (Altheide, 1987) followed by a Quantitative Content Analysis (Berelson, 1952) mirroring the approaches used by Williams et al. (2010) and Cann (2012) in their studies of the portrayal of identity within magazine advertisements. Results of this analysis highlighted five identity characteristics (places of play, equipment functionality, risk taking, competitiveness, activity aesthetics), three of which varied significantly between differing formats of mountain biking (risk taking, competitiveness, activity aesthetics). Activity aesthetic was established as a component of risk-taking rather than an independent identity characteristic and therefore risk taking along with competitiveness formed the basis of a refined four-format activity categorization within mountain biking and the production of a model of participant archetypes.

Keywords: mountain biking, identity, risk-taking, competition, extreme sport

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INTRODUCTION

The collective activities that would become known as extreme sports, of which mountain biking is one example, emerged as a reaction against social living patterns (Donnelly, 1988) and developed an ethos that set them apart from mainstream sports culture (Maguire, 1999). They have been described as lifestyle sports (Wheaton, 2004a) with strong subcultural values (Wheaton and Beal, 2003; Wheaton, 2007; McEwan, 2016) and associations to patterns of consumerist consumption (Wheaton, 2013). Such patterns of consumption impact upon the identities present within extreme sports and this study sought to address this point through an analysis of the sport of mountain biking.

Since its birth, mountain biking has evolved pluralistically into a complex arrangement of specialist activities (McEwan and Weston, 2017), which have been suggested to present differing subcultural values (McEwan, 2016). However, this remains largely unexplored within the literature and raises questions over the homogeneity of mountain biking as a unified culture. McEwan and Weston (2017) demonstrated how the mountain bike market consists of six market segments, each offering products designed for differing types of riding and thus facilitating particular behaviors. In postmodernity, products allow individuals to demonstrate self-symbolism (Elliott, 1997) and advertisements for consumables serve to create and reinforce identity (Elliott and Wattanasuwan, 1998; Elliott and Davies, 2006). This study sought to bring these concepts together in an investigation of identities depicted within mountain bike magazine advertisements.

Identity itself is a reflexive characteristic (Goffman, 1959) and the fluid nature of 'self' represents a constructed face that individuals present within social interactions (Gergen, 1965, 1982; Turner, 1988). As a "reflexive project," (Giddens, 1991, p.32) identity is constructed, selected and ultimately managed as a process of self-representation. Individuals select how they want to represent themselves and be seen by the outside world. Equally social identity plays a constructive role in the facilitation and formation of relationships (Tajfel, 1972, 1978) and therefore the groups that individuals are associated with play a component part in defining their identity. Identity can facilitate membership of a group but the desire to enter social configurations can influence individuals to alter or adapt their identity in order to achieve association. This can clearly be viewed within extreme sports through the styles of dress, language, etiquette and even subcultural values adopted by participants (Beal, 1995, 1996, 1998; Anderson, 1999; Heino, 2000; Beal and Weidman, 2003; Wheaton and Beal, 2003; Wheaton, 2003, 2004a,b, 2007, 2010; Bennett and Lachowetz, 2004; Donnelly, 2006; Rinehart, 2007; McEwan, 2016).

Research on extreme sports has seized upon the attachment of these 'new' sports to cultural and identity narratives, which are at odds with mainstream sports culture (Midol, 1993; Beal, 1995, 1996; Le Breton, 2000; Wheaton, 2003, 2004a,b, 2007, 2010, 2013; Wheaton and Beal, 2003; Bennett and Lachowetz, 2004; Puchan, 2005; Donnelly, 2006). The identities assumed by those taking part in these emerging sports is important as it allows participants to define themselves as subcultural devotees through a demonstration of authenticity (Beal and Weidman, 2003; Wheaton and Beal, 2003). In order to conform, the serious participant must opt into the group identity in order to establish membership. Cultural characteristics therefore become tangible as a reflection of subcultural values and embody the sport's identity narratives (Heino, 2000; Donnelly, 2006) and in particular their masculinised nature (Anderson, 1999; Sisjord, 2009; Thorpe, 2010; Huybers-Withers and Livingston, 2010; Huybers-Withers, 2015). The question here, therefore, centers on the how identities are depicted and promoted to participants through advertising materials related to mountain biking products.

McEwan and Weston (2017) formally observed the pluralized nature of mountain biking and drew attention to the need for further analysis of the different identities within the sport in order to understand how differing participant narratives present themselves. This study sought to explore this with the objective of establishing core idealized identity narratives within mountain biking and defining how they might differ between the various formats of the sport. The need to carry out such research stems from a desire to establish how mountain bike markets marry up to participant identity narratives, thus developing practicable knowledge for those marketing products and services to consumers. In this respect advertisements play a significant role in the portrayal of identity to target markets (see Consterdine, 2002; Williams et al., 2010; Cann, 2012). This is particularly important, as it has been shown that consumers gravitate toward products, services and brands that reflect identities that they possess (Bhattacharjee et al., 2014).

The bicycle market has tended to be viewed as a flourishing industry over recent years. As an example of this, sales of bicycles in the United Kingdom alone rose by 14% between 2008 and 2013 (Mintel, 2014) and this is representative of a trend that has been replicated globally (see Confederation of the European Bicycle Industry, 2015). This has also led to large increases in profits for multinational cycle manufacturers, such as Shimano (Bicycle Retailer, 2016). However, reports within the cycling industry since 2015 have begun to focus on stagnation with the cycling market (see Harker, 2015; Sutton, 2015; Reid, 2018) and this represents a significant challenge to those marketing products within an increasingly challenging consumer landscape. A well-established solution to stagnating markets is to focus on clear strategies to cultivate interest amongst consumers (Estelami, 2010). One way of doing this is by better understanding consumer groups (Ames and Hlavacek, 1984) and thus being in a more advantageous position to market products more effectively. Therefore, an analysis of identity in mountain biking, as a core element of the cycling industry, will be of major benefit to those marketing products to consumers.

Therefore, the study sought to achieve three particular research aims: firstly, to establish the identity characteristics within the sport of mountain biking and secondly, to establish and map how these identities differ between various formats of the sport. As a third and final aim, the ambition was to utilize the knowledge gained while addressing aims 1 and 2 in order to develop a model of mountain biker identity that could form the basis of future research.

MATERIALS AND METHODS

The study was split into three phases. In the initial inductive phase, an Ethnographic Content Analysis (ECA; Altheide, 1987) was conducted, which allowed key identity characteristics to emerge through thematic semiotic analysis using the same approach used by both Williams et al. (2010) and Cann (2012). In phase two, a Quantitative Content Analysis (QCA; Berelson, 1952) was employed to establish if there were any identity differences evident between the various forms of mountain

biking. These first two phases fundamentally conform to the qualitative-quantitative sequential triangulation design described by Creswell (2003). The third phase of the study consisted of a secondary analysis of the QCA data using a Multidimensional Scale Analysis (MDS; Kruskal and Wish, 1978). This echoed the approach used by McEwan and Weston (2017) and made it possible to visually map the proximal similarities and differences of the various formats of mountain biking.

Materials

The study made use of the advertisements taken from four United Kingdom based mountain bike magazine publications (*Mountain Bike Rider*, *Dirt Mountain Bike Magazine*, *Mountain Bike UK*, & *What Mountain Bike*). It is noted that other sources could have been used (e.g., websites), however magazines remain a prominent marketing communication channel and it was felt that studying advertisements placed by manufacturers to engage with consumers in the print media would give a valid insight into idealized mountain bike identity. Each magazine was published on a monthly basis with large circulation rates and the sample was drawn from two years (2009 and 2013) to ensure stability within the data. Advertisements that appeared multiple times, (either in different magazines or repeated in various editions of the same publication) were included only once within the sample.

Only advertisements that could clearly be attached to particular formats of mountain biking were included within the study. However, it was noted that several formats identified by McEwan and Weston (2017) were either not represented within the sample (trials riding and marathon racing) or were present only in low numbers (slope style $n = 4$, northshore riding, $n = 7$ and four-cross racing $n = 9$). These formats represented only 3.4% of the original sample of 588 advertisements and in order to avoid drawing incorrect conclusions from such a small number of advertisements related to these formats, they were withdrawn from the study. The remaining sample of 568 advertisements was made up of eight categories of mountain biking, consisting of cross country ($n = 77$, raced on relatively flat courses), downhill and enduro downhill ($n = 106$ and $n = 27$, raced on short or long downhill courses, respectively), trail riding ($n = 142$, recreational trail riding in the countryside), all mountain ($n = 71$, recreational trail riding in the high mountains), freeriding ($n = 73$, off-piste riding often in the high mountains), dirt jumping and street riding ($n = 48$ and $n = 24$, trick orientated mountain biking).

PHASE 1: ETHNOGRAPHIC CONTENT ANALYSIS (ECA) METHOD

In order to evaluate and classify the advertisements, an ECA was conducted with a focus on the semiotic appraisal of the sample material (see Krippendorff, 1980; Schroeder, 2006). Content analysis methodologies have been traditionally quantitative in nature (e.g., Neuendorf, 2002), however the use of this approach within a qualitative paradigm has become increasing common (see Mayring, 2004) and the study design used within the first phase of this research utilized the approach developed by Altheide (1987). The aim within the first phase of the study was to discern the identities portrayed within the sample as a whole and draw out the cultural meanings in relation to the various formats of mountain biking. In this sense, the initial phase of the study sought to establish the subcultural values across all forms of mountain biking.

Ensuring the validity of the observations made in the ECA phase of this study required consideration. As Daymon and Holloway (2011) point out, to analyze advertisements using semiotics requires the researcher to explore the cultural communication between the seller and the consumer. However, such communication is aimed at an informed consumer market, and therefore cultural messages often cannot be easily perceived by those unfamiliar with the culture itself.

The primary researcher initially established codes and identity themes through interpretive observation. In each individual case the advertisements were observed and evaluated through a semiotic process (see Eco, 1976) based on their content. To this extent, both the imagery and text present within each individual advertisement was evaluated and deciphered to discern an observable cultural meaning. These initial observations led to a large number of lines of content. The lead researcher then took these and inductively analyzed them to form codes, by drawing together and grouping observations based on the raw material generated within the sample. The descriptions shown within the tables in the results section below represents a summary of the lines of content that made up each individual code.

Given the large sample used within this study and the array of observations made, the semiotic approach used became key within the process. Once the codes were established these were then evaluated and drawn into higher order identity themes. During this phase of analysis, a focus was also placed on separating identity themes, which were core within mountain biking as a whole from those that appeared to be represented more frequently in particular formats. These differing identity themes were then carried forward into the analysis conducted within the second phase of this study.

Ordinarily good practice would be to conduct thematic coding and data reduction that is independently verified by fellow researchers. However, the obvious insider culture present within extreme sports, such as mountain biking meant that an additional validation process was needed within this study. In this case the primary researcher was an active mountain biker with over eighteen years of experience within the sport, who therefore possessed an insider knowledge of the culture along with expertise in content analysis methods. Two researchers also with experience of using content analysis methodologies corroborated the established themes, but both possessed a limited knowledge of mountain bike culture. In order to mitigate against this, themes were additionally verified by two experienced mountain bikers, both with over fifteen years of experience within the sport. Using this approach meant that the codes developed within this study were verified methodologically (by fellow researchers) and culturally (by mountain bikers), making the semiotic process more reliable.

The codes themselves were developed inductively as there was no preconceived idea of the content that would be portrayed within the advertisements. These codes were then clustered in

identity themes through the semiotic process at the heart of ECA (Altheide, 1987) and reflecting the process used by Williams et al. (2010) and Cann (2012).

PHASE 1: ECA RESULTS

The ECA results established 11 codes that were arranged under five identity themes within mountain biking (see **Tables 1**, **2**). These included: the sites where mountain biking takes place (places of play); the use of complex and high-tech equipment (equipment functionality); the attachment to traditional forms of competition (sporting characteristics); the association of mountain biking to danger and risk taking (the importance of risk); and finally artistic creativity (activity aesthetics).

It was noted during the ECA phase of the study that two characteristics appeared commonly across all formats of mountain biking (see **Table 1**). The presence of 'places of play' and 'equipment functionality' within the sample was noted to emerge so frequently that these were considered to be universal characteristics evident across all formats of mountain biking. However, the three remaining categories (sporting characteristics, the importance of risk, and activity aesthetics) were found to differ between the various styles of mountain biking (see **Table 2**). Therefore, these were carried forward for statistical investigation in the second phase of this research.

In taking this approach this does in no way diminish the importance of places of play and equipment functionality as identity themes in mountain biking as their universality demonstrates them to be key features across the sport as a whole. However, the purpose of this study was to unpick the differences in identity across the various formats of mountain biking and therefore it was the differences noted under semiotic analysis that were explored and evaluated further in the second phase of this research.

PHASE 2: QUANTITATIVE CONTENT ANALYSIS (QCA) METHOD

As has been noted within the initial phase of this research. sporting characteristics, the importance of risk, and activity aesthetics appeared to present areas of difference and could therefore facilitate the production of archetypes of mountain biker identity. It therefore became important to establish if and where differences between these three identity themes occurred. Returning to the sample and using the initial ECA findings, a second stage of data collection and analysis was conducted. This took the form of a QCA using the approach formulated by Berelson (1952) and described by Riff et al. (2014) for advertisement-based research. Individual advertisements were assessed for the presence of each of the seven codes, which emerged from the ECA findings and related three identity themes (risk taking, competitiveness and activity aesthetics). If an individual code was present within the advertisement then it was scored as such. These scores were then accumulated under the three identity themes, meaning that seven codes were looked for in each individual advertisement. The cumulative presence of the codes, under each of the identity themes, led to each advertisement within the sample having three individual scores for competitiveness, risk taking and activity aesthetics. It was these cumulative scores that were used to conduct a statistical examination of this data.

The codes that were sought out within each individual advertisement were as follows:

Competitiveness:

(1) The celebration of sporting success through achievement or the identification of symbols of success (e.g., world championship stripes).
(2) The presence of participants wearing 'racing kit or racing uniform.'
(3) Competing in events or training for events.
(4) The professionalization of amateur sport through training, psychology or high-tech equipment.

Risk-taking:

(1) Behaviors and practices identified that could result in serious injury or death.
(2) The identification of protective equipment that goes beyond the basics of a standard helmet and gloves (e.g., full face helmet, knee pads or neck brace).

TABLE 1 | The two core identity characteristic themes associated with all mountain biking.

Identity themes	Codes	Description of observations
Places of play	Man-made spaces	The use of non-natural resource spaces fell into two categories. These constituted the use of specifically designed spaces for mountain biking (e.g., jumps built specifically for freestyle forms of mountain biking) or where riders used the cityscape and urban furniture creatively as part of their participation in mountain biking.
	Use of the natural landscape	The application of man-made alterations to the natural landscape in order to facilitate particular forms of mountain biking (e.g., the development of rural trail centers and race courses).
Equipment functionality	Purposeful nature to the equipment	The use of equipment as a functional resource in aiding human performance via the identification of key product characteristics (strength, durability, weight and quality) in relation to the purpose that it serves the participant.
	Equipment quality and functionality	The quality of equipment in validating its usefulness in aiding human performance through the association of products with leading professional mountain bikers. This was also achieved through the identification within the adverts of favorable product reviews to develop a sense of product quality.

TABLE 2 | The three identity characteristic themes associated with mountain biking that were noted to varying between the various formats of the sport.

Identity Themes	Codes	Description of observations
Sporting characteristics	Celebration of sporting success	The attachment of products to successful athletes (e.g., riders winning world cup races).
	The adoption of a 'sporting' visual identity	Use of performance related cycling kit such as lycra or downhill race uniforms to identify riders as competitors.
	Competing and training to compete	The identification of practices performed outside of competition that increases performance abilities for participants (e.g., training, use of training aids and sports science) as well as actually competing in organized and structured events. This also had elements of modern phenomena related to competition such as gamesmanship.
	Professionalization of amateur participants	Reference being made to the psychological aspect of competition to emphasis a professional approach within amateur sports participants. In addition this also included the democratization of access to professional standard equipment for sub-elite riders.
The importance of risk	Risk taking behaviors	Specific examples of risk taking behaviors such as 'hucking' in freeriding and the performance of dangerous tricks and stunts. Also the identification of the consequences of risk taking (e.g., serious injury or death).
	The need for protection	The wearing of protective equipment such as knee and elbow pads, neck braces and also the adopted use of full-face helmets.
Activity aesthetics	Demonstration of creativity	The emphasis of artistry and creativity within the activity format through the performance of tricks.

Activity Aesthetics:

(1) The demonstration of creative and artistic practices (e.g., tricks) within the activity format.

In line with the recommendations of Jamieson (2004) and Cohen et al. (2007), non-parametric analysis methods were employed due to the ordinal nature of the data analyzed in this phase of the study. Initial examinations were conducted using a Kruskal–Wallis *H* test (Kruskal and Wallis, 1952) to establish intergroup difference. As there is no *post hoc* method that can be applied to establish where differences exist between groups, a series of Mann–Whitney *U* tests (Mann and Whitney, 1947) were employed, comparing each form of mountain biking in turn with one another. These eight groups were Cross Country, Downhill, Enduro Downhill, Freeride, All Mountain, Dirt Jumping, Street Riding and Trail riding as have been described previously. With this being the case, the Mann–Whitney *U* test (Mann and Whitney, 1947) required seven comparisons to be made and therefore a Bonferroni correction was carried out ($p = 0.007$) to ensure that no type I error was made within the analysis (see Fields, 2013).

The initial findings of this phase indicated similarities in subscale scores between some formats of mountain biking. These were then drawn together into four broader categories, which were then retested again using the method detailed above. These new categories were labeled as Cross County (XC), Downhill (DH), Freestyle (FS) and Trail (TR) and are discussed in the detail in the results section below. However, in retesting these wider grouping categories for the existence of difference only three comparisons were required for the Mann–Whitney *U* tests (Mann and Whitney, 1947). Therefore, a Bonferroni correction was again made to the probability level ($p = 0.017$, see Fields, 2013) for these additional tests of difference.

PHASE 2: QCA RESULTS

Initial examination of the scores for each of the identity themes, across the various formats present within the sample was conducted using a Kruskal–Wallis *H* test (Kruskal and Wallis, 1952). This demonstrated that significant differences between the eight formats of mountain biking did exist for competitiveness ($p < 0.001$), risk taking ($p < 0.001$) and activity aesthetics ($p < 0.001$). Therefore each of these identity characteristics was tested further using a series of Mann–Whitney *U* tests (Mann and Whitney, 1947) to establish where the intergroup differences were apparent between riding styles.

Competitiveness was the factor that most clearly delineated styles of mountain biking (see **Table 3**). Three styles of mountain biking (enduro downhill, downhill and cross country) stood out as showing a significantly greater affinity to competitiveness than other forms of mountain biking. It is notable that no significant differences were found between these three styles of mountain biking when they were tested against one another. Likewise, street riding, trail riding, dirt jumping, all mountain and freeride did not show any significant variation between themselves either, prompting the proposal of two groups of mountain biking; one high competitive cohort and one correspondingly lower in competitiveness.

For risk-taking the distinctions were less obvious. However, it was still possible to discern a high and low category for this identity characteristic (see **Table 4**). Both cross country and trail riding were found to score significantly lower for risk taking than all other formats, and therefore appear to be obvious candidates for a proposed low risk group. However, these can also be joined by all mountain, which was found to be significantly lower in this characteristic than enduro downhill, dirt jumping, street riding, downhill and freeride. It also did not differ significantly when compared to trail riding. Although, it was found to be significantly higher than cross country ($p = 0.001$), which was the lowest scoring group in terms of risk in the sample. The fact

TABLE 3 | Comparative association of competition between riding styles.

	Low competitiveness					High competitiveness		
	Street riding	**Trail riding**	**Dirt jumping**	**All mountain**	**Freeride**	**Enduro downhill**	**Downhill**	**Cross country**
Street riding (*n* = 24)		*P = 0.471* *r = −0.06*	*p = 0.696* *r = −0.05*	*p = 0.388* *r = −0.09*	*p = 0.253* *r = −0.12*	***p < 0.001*** ***r = −0.72*****	***p < 0.001*** ***r = −0.50*****	***p < 0.001*** ***r = −0.55*****
Trail riding (*n* = 142)			*p = 0.682* *r = −0.03*	*p = 0.734* *r = −0.02*	*p = 0.351* *r = −0.06*	***P < 0.001*** ***r = −0.65*****	***p < 0.001*** ***r = −0.69*****	***p < 0.001*** ***r = −0.70*****
Dirt jumping (*n* = 48)				*p = 0.539* *r = −0.06*	*p = 0.311* *r = −0.09*	***p < 0.001*** ***r = −0.70*****	***p < 0.001*** ***r = −0.58*****	***p < 0.001*** ***r = −0.63*****
All mountain (*n* = 71)					*p = 0.620* *r = −0.04*	***p < 0.001*** ***r = −0.68*****	***p < 0.001*** ***r = −0.63*****	***p < 0.001*** ***r = −0.66*****
Freeride (*n* = 73)						***P < 0.001*** ***r = −0.64*****	***p < 0.001*** ***r = −0.61*****	***p = 0.001*** ***r = −0.64*****
Enduro downhill (*n* = 27)							*p = 0.247* *r = −0.10*	*p = 0.059* *r = −0.19*
Downhill (*n* = 106)								*p = 0.162* *r = −0.10*
Cross country (*n* = 77)								

*Mountain bike styles are ranked from left to right in order of their mean rank scores for this identity characteristic. Significant differences shown in bold. *at p < 0.007, **at p<0.001, with correlations ranked from left to right within the table.*

TABLE 4 | Comparative association of risk-taking between riding styles.

	Low risk			High risk				
	Cross country	**Trail riding**	**All mountain**	**Enduro downhill**	**Dirt jumping**	**Street riding**	**Downhill**	**Freeride**
Cross Country (*n* = 77)		*p = 0.068* *r = −0.12*	***p = 0.001*** ***r = −0.28****	***p < 0.001*** ***r = −0.66*****	***p < 0.001*** ***r = −0.69*****	***p < 0.001*** ***r = −0.83*****	***p < 0.001*** ***r = −0.73*****	***p < 0.001*** ***r = −0.85*****
Trail riding (*n* = 142)			*p = 0.010* *r = −0.18*	***p < 0.001*** ***r = −0.54*****	***p < 0.001*** ***r = −0.63*****	***p < 0.001*** ***r = −0.70*****	***p < 0.001*** ***r = −0.72*****	***p < 0.001*** ***r = −0.84****
All mountain (*n* = 71)				***p < 0.001*** ***r = −0.38*****	***p < 0.001*** ***r = −0.47*****	***p < 0.001*** ***r = −0.56*****	***p < 0.001*** ***r = −0.57*****	***p < 0.001*** ***r = −0.73*****
Enduro downhill (*n* = 27)					*p = −0.502* *r = −0.08*	*p = 0.167* *r = −0.19*	*p = 0.045* *r = −0.17*	***p < −0.001*** ***r = −0.44*****
Dirt jumping (*n* = 48)						*p = 0.392* *r = −0.10*	*p = 0.132* *r = −0.12*	***p < −0.001*** ***r = −0.40*****
Street riding (*n* = 24)							*p = 0.797* *r = −0.02*	***p < 0.001*** ***r = −0.36*****
Downhill (*n* = 106)								***p < 0.001*** ***r = −0.38*****
Freeride (*n* = 73)								

*Mountain bike styles are ranked from left to right in order of their mean rank scores for this identity characteristic. Significant differences shown in bold. * at p < 0.007, ** at p < 0.001, with correlations ranked from left to right within the table.*

that the difference between all mountain and enduro downhill (the next highest risk-taking format) occurred with an above moderate effect size ($r = -0.38$) means that placing all mountain in the low risk taking category and enduro downhill in the higher group for this identity theme was deemed appropriate.

Although all mountain is described here as belonging in a low risk-taking category, it would arguably appear at the upper reaches of this group and the hierarchy developed here should be viewed as a continuum rather than truly discrete categories. A similar situation was also seen in the high-risk category, where freeride displayed a significantly stronger attachment to risk-taking identities than all other formats of mountain biking and therefore the conclusion can be drawn that within the group most associated with risk-taking, freeride is the category that sits at the head of the spectrum.

The statistics displayed in **Table 5** show that freeride, dirt jumping and street riding, while not differing from each other were found to significantly attach more strongly to activity aesthetics and thus form the group that presented this identity more strongly. While the other formats (trail riding, cross country, enduro downhill and downhill) become the alternative low aesthetics group it must be noted that there were significant differences between several of these styles of mountain biking (trail riding and all mountain; trail riding and downhill; and

TABLE 5 | Comparative association of activity aesthetics between riding styles.

	Low Aesthetic Association					High Aesthetic Association		
	Trail Riding	**Cross Country**	**All Mountain**	**Enduro Downhill**	**Downhill**	**Freeride**	**Dirt jumping**	**Street riding**
Trail riding (*n* = 142)		*p = 1* *r = −0.00*	*p = 0.045* *r = −0.14*	***p = 0.001*** ***r = −0.25****	***p < 0.001*** ***r = −0.24****	***P < 0.001*** ***r = −0.62****	***p < 0.001*** ***r = −0.70****	***p < 0.001*** ***r = −0.85****
Cross country (*n* = 77)			*p = 0.139* *r = −0.12*	*p = 0.016* *r = −0.24*	***p = 0.006*** ***r = −0.20****	***p < 0.001*** ***r = −0.58****	***p < 0.001*** ***r = −0.66****	***p < 0.001*** ***r = −0.83****
All mountain (*n* = 71)				*p = 0.307* *r = −0.10*	*p = 0.087* *r = −0.13*	***p < 0.001*** ***r = −0.53****	***p < 0.001*** ***r = −0.61****	***p < 0.001*** ***r = −0.77****
Enduro downhill (*n* = 27)					*p = 0.744* *r = −0.03*	***p < 0.001*** ***r = −0.38****	***p < 0.001*** ***r = −0.48****	***p < 0.001*** ***r = −0.68****
Downhill (*n* = 106)						***p < 0.001*** ***r = −0.45****	***p < 0.001*** ***r = −0.51****	***p < 0.001*** ***r = −0.62****
Freeride (*n* = 73)							*p = 0.457* *r = −0.0.7*	*P = 0.029* *r = −0.22*
Dirt jumping (*n* = 48)								*p = 0.124* *r = −0.18*
Street riding (*n* = 24)								

*Mountain bike styles are ranked from left to right in order of their mean rank scores for this identity characteristic. Significant differences shown in bold * at $p < 0.007$, ** at $p < 0.001$, with correlations ranked from left to right within the table.*

cross country and downhill), however these were found with low effect sizes ($r = -0.14$, $r = 0.24$, $r = -0.20$ respectively). By comparison the highest format in the low aesthetics group (downhill) compared to the lowest in the high category (freeride) was found to be significant with a much greater effect size ($r = -0.45$), adding weight to the proposed categorization of styles of mountain biking.

From these findings it is possible to cluster formats of mountain biking into four categories: Cross Country (XC) demonstrates highly competitive but low risk and low aesthetic characteristics; DH, made up of downhill and enduro downhill, demonstrates a highly competitive and risk-orientated nature with low aesthetics; FS, consisting of street riding, dirt jumping and freeride, can be characterized as being low competitive pursuits with strong attachments to risk and aesthetic; and Trail Riding (TR), made up of trail riding and all mountain, is weakly attached to all three characteristics.

Through repeat testing, again using an initial Kruskal–Wallis *H* test (Kruskal and Wallis, 1952), these new groups (DH, XC, FS, and TR) were also found to differ significantly from one another (competitiveness, $p < 0.001$; risk-taking, $p < 0.001$; activity aesthetics, $p < 0.001$). These new groups were then tested using a series of Mann–Whitney *U* tests (Mann and Whitney, 1947) to establish where the intergroup differences existed.

Downhill was found to possess a significantly greater attachment to risk than TR ($p<0.001$, $r = -0.64$) and XC ($p < 0.001$, $r = -0.64$) as did FS (TR- $p < 0.001$, $r = -0.70$; XC- $p < 0.001$, $r = -0.69$). However, FS was found to present a significantly greater risk identity than DH ($p = 0.002$, $r = -18$) but no significant difference was found between XC and TR. Both XC and DH were found to be significantly more competitive than TR (XC- $p < 0.001$, $r = 0.69$; DH- $p < 0.001$, $r = -0.69$) and FS (XC- $p < 0.001$, $r = -0.69$; DH- $p < 0.001$, $r = -0.66$) but not in comparison to each other. For aesthetic, FS scored significantly higher than all other categories (XC- $p < 0.001$, $r = -0.55$; TR- $p < 0.001$, $r = -0.64$; DH- $p < 0.001$, $r = -0.49$) and DH was found to be significantly higher than both XC ($p = 0.007$, $r = -0.19$) and TR ($p < 0.001$, $r = -0.20$). No significant differences in activity aesthetic were found between XC and TR.

From the results of the analysis of the regrouped data it is clear that both activity aesthetics and risk taking show a similar trend with both XC and TR being low in these characteristics, FS being the highest and DH being best described as moderate. The performing of tricks and aesthetic movements in mountain biking naturally and quite logically involves taking risks. As an example of this, the main form of aesthetic movement portrayed within the sample was where riders performed tricks in the air while jumping. This obviously creates an additional risk factor and the link between risk taking and aesthetics within the sample of advertisements appeared to occur simultaneously. This possibly indicates that activity aesthetics is simply a form of heightened risk taking rather than a separate identity theme in its own right. If this is the case then the relationship between competitiveness and risk taking becomes the primary focus of identity difference in mountain biking, with activity aesthetic being a factor which differentiates between moderate risk taking from more extreme and dangerous formats of the sport. This relationship can be seen modeled in **Figure 1** and this dynamic became a major focus of the analysis conducted within the third phase of this study.

PHASE 3: MULTIDIMENSIONAL SCALE ANALYSIS (MDS) METHOD

McEwan and Weston (2017) analysis of the mountain bike market made use of an MDS analysis to model differing segments. This approach to grouping and classifying results was replicated in a final test conducted on the QCA data. In taking this approach, this study was able to retest and

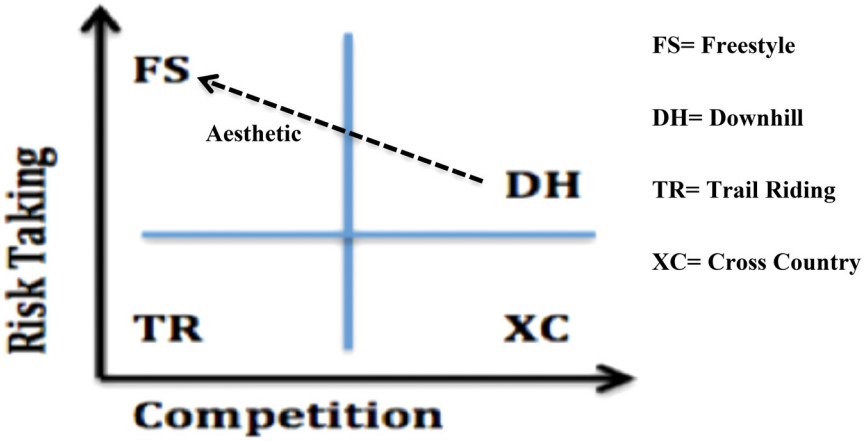

FIGURE 1 | A model of difference between formats of mountain biking.

corroborate the groupings found in the initial QCA phase of the study.

The data was analyzed through the use of the mean scores for each of the eight formats of mountain biking in relation to the three previously established identity characteristics (competition, risk taking and aesthetic behavior). MDS analysis allows for the measurement of dichotomous items (see Coleman, 1957; Kruskal and Wish, 1978; DeSarbo et al., 1997; Borg and Groenen, 2005; Mugavin, 2008), in this case forms of mountain biking and each characteristic. Individual styles of mountain biking were compared pair-wise and differences between group mean scores were placed in an upper-triangular matrix ready for analysis using the Proxscal algorithm (Kruskal and Wish, 1978).

An initial principal component analysis (PCA) was conducted, which was followed by the production of a common space diagram again using the Proxscal algorithm (Kruskal and Wish, 1978). The common space diagram was interpreted using the findings of the QCA analysis and also through direct comparison with the results of McEwan and Weston (2017) analysis of the mountain bike market.

PHASE 3: MDS ANALYSIS RESULTS

The PCA (see screen chart in **Figure 2**) shows the elbow point in the distribution of raw stress scores occurring at two dimensions, indicating that there are two rather than three differences between styles of mountain biking. This corresponds to the suggestion drawn from the QCA results that indicate activity aesthetic to be an extension of risk taking rather than an identity characteristic in its own right. A bi-dimensional common space diagram was therefore produced, again using the Proxscal algorithm (Kruskal and Wish, 1978), in order to map the proximities of mountain bike styles based on the QCA results found within this research.

As shown in **Figure 3** this data was then interpreted in two ways. Firstly, the groupings that were found through the QCA analysis were replicated in the proximities shown on the common space diagram, providing further weight to the categories that have been proposed. **Figure 3** also shows the two key identity differences (risk taking and competitiveness) as axes superimposed on the common space chart, again reinforcing the initial QCA findings.

The QCA analysis found that FS was significantly higher in activity aesthetic and thus represents increased risk-based practices and this, in connection with the MDS analysis, can be seen represented on the MDS common space diagram (see **Figure 3**) and corresponds with the previously proposed model of the relationship between differences in identity across the four categories of mountain biking, as shown in **Figure 1**.

In comparison to McEwan and Weston (2017) study of the mountain bike market, the MDS common space results found within this study show notably similar proximities between the differing styles of mountain biking. However, it also needs to be stated that the interpretation of the results in this study leads to a difference in the clustering of mountain bike styles. Where McEwan and Weston (2017) found six categories of mountain biking based on products and the participant opinions, thus allowing for the establishment of distinct market segments (cross country, trail riding, all mountain, enduro downhill, gravity and freestyle), this study found that, based on identity, mountain biking consisted of four categories of riding formats (FS, DH, XC, and TR).

DISCUSSION

In developing a model of the pluralized mountain biking market, McEwan and Weston (2017) concluded by posing a question regarding how this could possibly be reflected in participant identities. This study attempted to address this question by evaluating the identity characteristics of each format of mountain biking through a semiotic analysis of mountain biking magazine advertisements. The findings of this study allow an insight into the identity narratives at the heart of particular formats of mountain biking and allow for the proposal of a model of

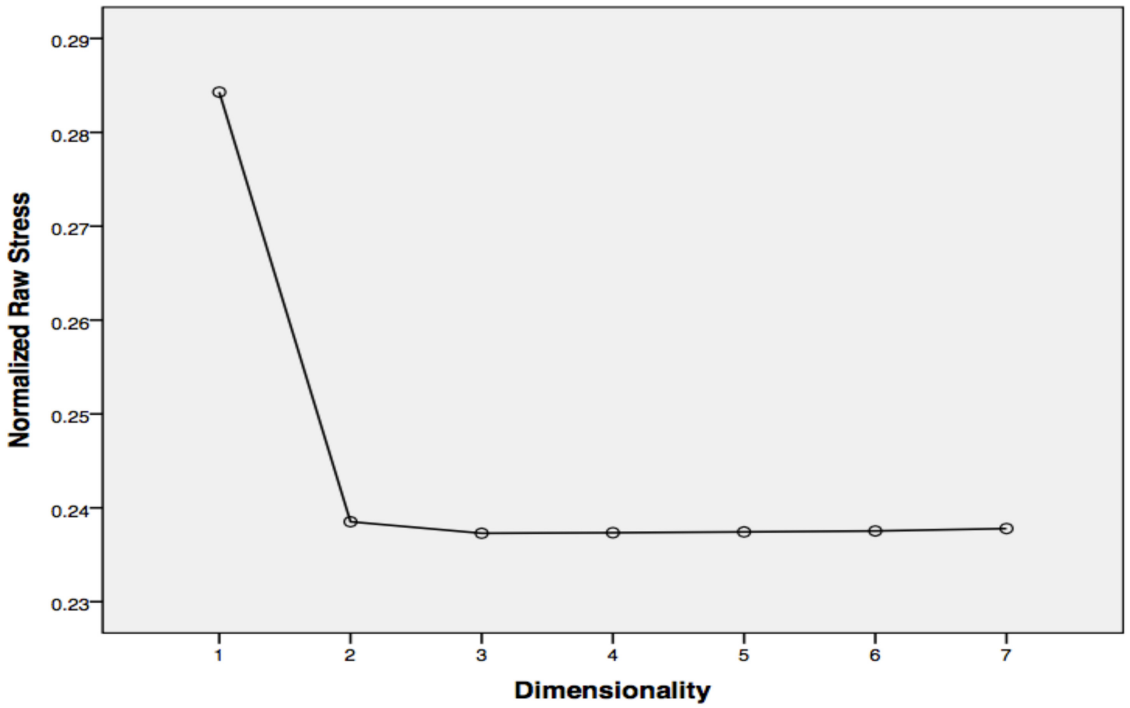

FIGURE 2 | MDS scree plot showing two-dimensional solution.

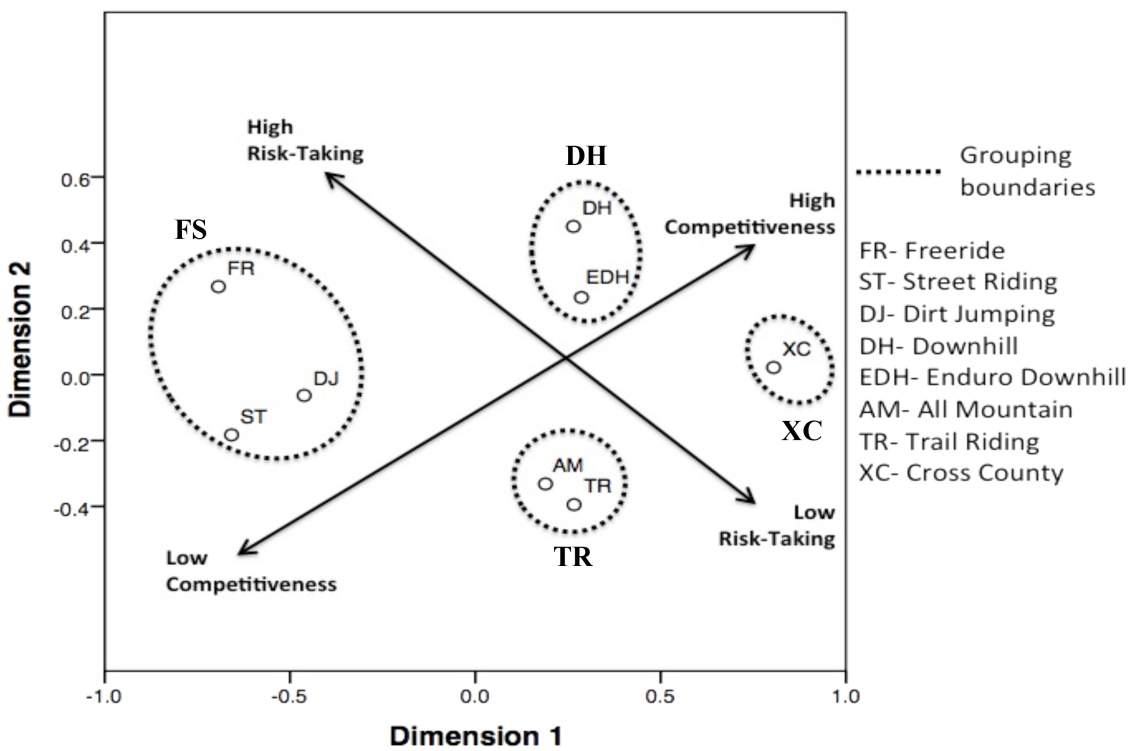

FIGURE 3 | Interpreted bi-dimensional MDS common space diagram showing the clustering of riding styles into the four groupings of Freestyle (FS), Downhill (DH), Cross Country (XC) and Trail Riding (TR).

participant archetypes that will be explored within the discussion presented below.

Lifestyle sports have been demonstrated to present strong identities that individuals can associate with (Wheaton, 2004a) and by deciding to take part in an extreme sport, participants begin a process of identity negotiation fuelled by the need to demonstrate subcultural authenticity (Beal and Weidman, 2003; Wheaton and Beal, 2003). Therefore, in extreme sports self-narratives become mediatised and marketable as commodities (Bennett and Lachowetz, 2004). In particular, in the sport of mountain biking, the work of Huybers-Withers and Livingston (2010) highlights how the media can be used to create and promote an identity in an extreme sport. However, Huybers-Withers and Livingston (2010) conducted their analysis based solely on the gendered nature of the identities associated within mountain biking. Although undoubtedly relevant to the analysis presented here, their work does not significantly account for the other factors of identity differences within the sport and therefore the result of this study provide a further and differing perspective on identity within the pluralized sport of mountain biking.

The results of this study provide evidence to suggest that extreme sports identities are not homogenous and that viewing all formats of a sport like mountain biking as being similar is overly simplistic. The results of this study support the notion that mountain biking is pluralized, not only in its markets (see McEwan and Weston, 2017) but also within the identities bound up within differing formats of the sport.

Mountain Biking Identities

Although five identity characteristics were found to be present within the sample of advertisements, it was notable that two emerged as being common across all forms of mountain biking. The results highlight links to a strong reliance upon technology and the man-made nature of the environments in which mountain biking takes place across all forms of mountain biking. This provides a common ground for all mountain biking formats and highlights the fact that although differences in identity have been found through this research, it is also recognized that similarities also exist. However, the purpose of this study was to establish areas of divergent identity and therefore the discussion presented here will center on the differentiating factors found within the results.

Three identity characteristics emerged from this study that could provide a level of differentiation between the various styles of mountain biking. The emergence of risk taking is a factor that has commonly been associated with extreme sports (Wheaton, 2004a; Rinehart, 2007; Zuckerman, 2007; Barlow et al., 2013, 2015; Frühauf et al., 2017) and indeed the term extreme is itself designed to place an emphasis on the risks involved. Equally Humphreys (2003) highlights the impact of the new leisure movement on the development of aestheticism and artistry within extreme sport, and again this emerged within this research. However, extreme sports have been previously described as possessing "counter cultural philosophies" (Donnelly, 1988, p. 74) that challenge the traditional sports construct (Maguire, 1999) and reject conventional competition (Beal, 1995; Humphreys, 2003; Wheaton, 2003; Wheaton and Beal, 2003). Therefore, it is notable that many traditional sporting characteristics were found within the semiotic analysis of the sample of advertisements, countering the popular image of extreme sports. This provides an example of the varying association of mountain biking formats to each of the three identity characteristics initially established within this study justified the need to further and deeper analysis this area.

Competitiveness

Sport is best defined from a sociological perspective using the framework devised by Guttmann (1978) in his ground-breaking work, *From Ritual to Records*. Invoking the Freudian concepts of mastery (Freud, 1924), he was able to delineate constructed activities (sports) from simple acts of play and define sport as being an organized and governed contest between co-facilitatory opponents. However, in extreme sports that contain no rules or have no externalized competition, then this thoroughly modern, rather than postmodern definition becomes problematic. Repeated reference is made within the extreme sport literature to participants rejecting traditional forms of competition (see Midol, 1993; Beal, 1995; Wheaton, 2004a, 2007, 2013; Donnelly, 2006). What is clear from the findings of this research is that certain mountain biking formats (cross country, downhill and enduro downhill) do conform to the framework set out by Guttmann (1978). The obvious point here is that the association to, or the rejection of, competitiveness is not universal, highlighting the non-homogenous nature of mountain biking identities.

If an activity conforms to the traditional construct of the 'contract to contest' between opponents, under the rules and regulations of a controlling authority, then it must be considered a sport under Guttmann (1978) definition. Equally if these mountain biking formats (cross country, downhill and enduro downhill) are to be categorized as sports then can they simultaneously remain extreme sports? Where other styles of mountain biking fall outside of this definition, the appearance is that mountain biking is made up of some formats, which are traditional sporting activities, while others portray the accepted narrative of the rejection of competition and are therefore extreme sports.

In its early development, mountain biking went through a process of sportification (Savre et al., 2010) but later developments (e.g., freeride) reject the competitive identity. The findings within this study provide evidence that suggests that a more complex competitive/non-competitive dynamic is present within this emerging sport than had previously been observed. Whilst this is an area that clearly requires further analysis, the present results demonstrate how difficult it is to fully categorize extreme sports using older models as a point of definition. It also highlights the need to revise the current thinking on what makes a sport a sport, without having to refer simply to competition.

Where competitiveness was noted within advertisements there were examples of imagery that would not have been out of place if connected to modern sport. The use of race kit serves to set competitors apart and create a sporting visual identity,

thus reinforcing the competitive self-narrative. This outwardly displays symbolic sporting commitment that conforms to ideals of dramaturgy (Goffman, 1959). By contrast, other forms of mountain biking displayed a visual persona designed to convey a relaxed attitude that creates a contesting identity narrative to that of competitive formats. Where racing is portrayed as being serious and requiring of commitment, non-racing styles of mountain biking are depicted as being laid-back and relaxed. Symbols of identity such as sports kit can be of use in equal measure to bring individuals together while also allowing groups to distinguish themselves from one another (Eitzen, 2012, p. 42). On the one hand, a distinction between competitors and non-competitors can be framed around the wearing of race kit, but equally the type of race clothing worn denotes the style of mountain biking an individual is competing in. Downhill racers were observed wearing moto-cross inspired clothing, while enduro downhillers wore baggy shorts and t-shirts. Cross country racers were adorned in lycra which would not have been out of place on road cyclists. So visual identity presents a significant characteristic for individuals engaged in competitive mountain biking.

There were other obvious symbols of competition (e.g., race numbers, racing images, celebration of sporting success, etc.) within race orientated mountain biking formats. However, there was also significant weight given to training in order to compete. This again is a coherent narrative that exists within traditional sports where the focus is on training to achieve. The ideal of achievement was widespread across all competitive formats of mountain biking and the use of heroes (professional riders) to emphasize the importance of success was clear. Hofstede et al. (1990) highlight this within their model of manifestations of culture, where heroes embody the attributes that are esteemed within the culture and thus represent its values. In the case of competitive mountain biking, this means sporting success and professional riders play a functional role in representing the subcultural values that reinforce this identity characteristic.

In reviewing the element of competitiveness, the conclusion can be drawn that a sporting identity in the traditional sense explored by Guttmann (1978) exists within some formats of mountain biking. McEwan (2016, p. 277) highlighted the role of mastery in his discussion of mountain bike participants' characteristics and the results established within this research provide further evidence to corroborate his theory of the emergence of the non-competitive "neo-sportsman." However, this could equally be the case in a number of postmodern sports and therefore this highlights the need for further analysis of the phenomenon that McEwan (2016) describes and how appears in extreme sports more generally.

Risk Taking and Activity Aesthetics

If extreme sports participants have in the past been caricatured as risk takers then the result of this study indicate that this is an unsubtle stereotype, which fails to reflect the diversity of identities in a sport such as mountain biking. To a large degree the association to risk suits the narrative of deviance that is prized within extreme sports subcultures. However, the adrenalin junkie myth has already been largely debunked (see Brymer, 2010). Undoubtedly, lifestyle sports contain elements of risk, which in some cases can be extreme in nature (Palmer, 2002, 2004; Simon, 2002). However, it has also been suggested that the risk itself is not the main attraction for participants in extreme sports (Brymer and Oades, 2008; Brymer, 2010). This is complicated by the fact that participants in extreme sports have been shown to possess higher sensation seeking traits than non-extreme sports participants (Cronin, 1991; Campbell et al., 1993; Jack and Ronan, 1998; Diehm and Armatas, 2004; Gomà-i-Freixanet, 2004; Gomà-i-Freixanet et al., 2012) and therefore if experiencing danger is not the main driver of participation, the sensation it provides is still significant (Zuckerman, 2007). However, even this notion has now been contested, with recent research beginning to take into account factors such as emotion regulation and agency within the risk sports experience (see Barlow et al., 2013).

The key observations made within this study connected to risk were twofold but both serve the purpose of reinforcing a sensation seeking and risk-based identity. On the one hand there is the promotion of risk-based practices, such as performing tricks or 'hucking' (performing large drops on a mountain bike). It was notable that within advertisements where tricks were being performed, that risk was a strongly associated element of the behavior. The insinuation within risk orientated advertisements was clear in demonstrating that under certain formats of mountain biking, risk taking is an inherently ingrained identity characteristic. This arguably provides the perception that in order to establish group membership and authenticity (Beal and Weidman, 2003; Wheaton and Beal, 2003) it becomes nearly compulsory for participants to engage in risk based subcultural behaviors.

Risk and danger obviously have possible consequences and this was demonstrated in several example advertisements, which included images of injury and crashes. To a great extent this serves a functional purpose, in that it develops and reinforces a strong core identity narrative for participants to benchmark themselves against as members of a subcultural community. Not only do participants have to take risks but they also have to be cognizant of the consequences (serious injury or death) should their actions go wrong. This symbolically differentiates between high and low risk forms of mountain biking and also extends to visual representation through the prevalence of protective equipment. Mountain bikers wear protective equipment regardless of the format they participate in (e.g., helmet and gloves) but in downhill and freeride there were strong connections to the use of more specialist protection (e.g., body armor, full-face helmets and neck braces). These obviously serve a functional purpose but significantly, they also provide a visually symbolic impression to outsiders, reinforcing the activity itself as being high risk and requiring extra security in the form of bodily protection and further reinforcing a risk taking identity.

Initial analysis indicated that activity aesthetic was a characteristic involved in mountain biking identity. However, further evaluation made it clear that rather than it being an independent factor, it was a constituent part of risk-taking.

As previously noted, all aesthetic behavior present within advertisements contained a strong element of risk. The analysis demonstrated that the formats of mountain biking that are more closely associated to extreme high risk are the aesthetic or freestyle formats. This aesthetic risk taking arguably could represent a substitution of one form of masculinity for another. As has been shown in other contexts, masculinity in extreme sports can take many guises (Beal, 1996; Robinson, 2004; Wheaton, 2004b) and in this instance competition and mastery of others appears to have been replaced by risk taking connected to aesthetics, particularly in freestyle mountain biking. However, this is not a firm conclusion of this study and further academic investigation of this area is strongly suggested.

Modeling Identity Archetypes in Mountain Biking

The results of the study presented here made it possible to draw together forms of mountain biking to create four rationally categorized groups. McEwan and Weston (2017) established six mountain bike markets. However, when identity rather than consumer products are observed it is clear that four clusters of riding styles emerge. The impact of developing these four format groups for mountain biking, along with the identification of risk and competition as defining identity characteristics, meant that it was possible to classify the structural relationship between the different styles of the activity. Based on this, four archetypal identities have been created, formulated around competitiveness and risk taking (which also includes aesthetics, see **Figure 4**). Each archetype represents participants from categorized clusters of riding styles. Recreationalists represent trail riding and all mountain, Competitors denotes cross country, Risk Competitors embody downhill and enduro downhill racing and finally, Aesthletes represent the freestyle forms of mountain biking (street riding, dirt jumping, and freeride).

Competitors are athletes (amateur or professional) who engage in low risk formats of mountain biking but compete regularly and train to prepare for events. Similarly, Risk Competitors also compete and train for events but differ from Competitors in the risk-based component of their style of riding.

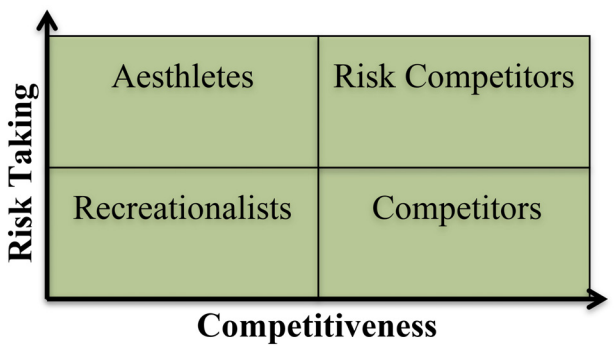

FIGURE 4 | Proposed model of mountain biking identity archetypes.

Aesthlete as they have been referred to here, are extreme high-risk takers that do not to associate with competition. The final category of the Recreationalists can best be described as what they are not. Recreationalist do not engage in competition and are low risk takers in comparison to both Aesthletes and Risk Competitors but share a pattern of low risk taking with the Competitors.

It is not possible to couch the findings of this study concerning risk within the context of previous research on mountain biking specifically as no studies beyond those centring on the epidemiology of injury have been conducted thus far. However, in previous research, extreme sports have more broadly been described as being high risk (Wheaton, 2004a; Donnelly, 2006; Rinehart, 2007). In addition, they have also been described as rejecting competition (see Beal, 1995; Wheaton and Beal, 2003; Wheaton, 2004a, 2007, 2013; Donnelly, 2006). When these two elements are combined and compared to the four archetypes developed within this research, the Aesthletes fit this stereotype most convincingly. However, it is important to note that this research has also identified three other archetypes and these do not readily conform to this depiction of extreme sports. Therefore this questions this description of the nature of extreme sports and the depiction of the risk taking anti-competitor within a homogenous sense would appear to be overly simplistic based on the findings within this study.

Building on previous research on the mountain bike market (see McEwan and Weston, 2017) this study moved the discourse into an analysis of identity. The findings of this study show competitiveness and risk taking to be component identity characteristics in mountain biking. It is recognized that the identity characteristics found in this study are based on the representation made within advertisements and that although this represents an idealized norm it does not automatically follow that these characteristics will be present amongst mountain bike participants themselves. This leads to possible future analysis of these factors as personality traits building on previous research in this area (e.g., Cazenave et al., 2007; Castanier et al., 2010), thus giving this area of study an additional psychological focus. Further research in this field of mountain biking would serve to link the visual identities found within this study with possible trait characteristics of riders themselves. Conducting future research in the area of personality traits would serve to confirm if the advertising materials within the mountain bike market are correctly aligned to the personality traits of the consumers. This study found strong divergences between identities in differing formats of the sport and it may be that these materials could be targeted better with an understanding of how personality traits connect with the identity characteristics found within this study. In practical terms, this information along with the findings of this study would be of use to those promoting products, services and facilities within the mountain bike market.

CONCLUSION

The findings of this research represent a contribution to knowledge in this field of study via the establishment of the

identity archetypes in the sports of mountain biking, which further the findings of McEwan and Weston (2017), which relate to the differing markets within the sport. The study findings presented here suggest that differing styles of mountain biking can be categorized under one of four groups (FS, XC, TR, and DH) and that participants themselves can be broadly defined under one of four archetypes (Competitors, Risk Competitors, Recreationalists and Aesthletes). The study found evidence highlighting two differing identity narratives that signify the differences between participant archetypes (competitiveness and risk taking). Initial analysis suggested that aesthetic was a third differentiating characteristic, however this was established as a component of extreme risk taking. Indeed it was found that the category with the highest association with risk taking (freestyle) was also the category with the strongest link to aesthetic. It was therefore concluded that within the sport of mountain biking the twin processes of competitiveness and risk taking act as defining identity characteristics and that these would provide a fruitful source for future research and analysis. In particular, a focus on the psychological trait characteristics (linked to competitiveness and risk taking) of those taking part in mountain biking would further illuminate this area of study and serve to further the conclusions within this research. Equally, it is noted that the analysis presented here focuses on a defined set of idealized identities which were drawn from a sample of advertisements for mountain biking products. It must be recognized that the self-identities that riders construct around their participation within the sport of mountain biking may not fully correspond with those found within this study. Therefore, it is recommended that further research is conducted focused specifically on mountain bike participants and their perceptions of the varying identities associated with the sport.

AUTHOR CONTRIBUTIONS

KM was responsible for the initial conceptualization of the study and the development of the research design, data collection, data analysis and interpretation, and drafting of the manuscript. NW and PG assisted in the data analysis and interpretation. They also worked on critically refining the manuscript for important intellectual content.

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Defining Extreme Sport: Conceptions and Misconceptions

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One feature of how sport is defined is the distinction between extreme and non-extreme sport. BASE jumping is an example of an "extreme sport" because it involves a high degree of risk, whilst swimming is classified as "non-extreme" because the risks involved are minimal. This broad definition falls short of identifying the extent of risk and ignores the psychological, social-demographic and life style variables associated with engagement in each sport.

Keywords: extreme sport, sport, high risk sport, defining sport, thrill seeking, action sport, adventure sport, BASE jumping

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INTRODUCTION

Indeed, the lack of consistency within the term "extreme sport" means that those wishing to study this field are forced to create their own criteria as a starting point, often in a less than scientific manner. This literary review of contemporary and historical research articles raises the key question of whether the definition of extreme sport is one of risk-taking with a high chance of injury or death or whether there are additional aspects to consider such as lifestyle or a relationship to the natural environment. This review does not examine any hypotheses and is a narrative based on key papers. Due to the lack of literature on this subject area it was not thought pertinent to conduct a systematic review.

The aim of this article is twofold: firstly, to demonstrate whether the term "extreme sport" in scientific terms, has developed into a misnomer, misleading in the context of the sports it tends to encompass, secondly, to propose a revised, more accurate definition of extreme sport, reflective of the activities it encompasses in the context of other non-mainstream sports. Based on this review it is argued that a new definition of an extreme sport is one of "a (predominantly) competitive (comparison or self-evaluative) activity within which the participant is subjected to natural or unusual physical demands. Moreover, an unsuccessful outcome is "likely to result in the injury or fatality of the participant, in contrast to non-extreme sport" (Cohen, 2016, p. 138).

"EXTREME SPORT" – CHALLENGING THE DEFINITION

The question of what is an extreme sport and whether the term "extreme sport" should be used to label particular sports can be viewed from a variety of angles. "Extreme sport" appears to be used interchangeably with "high risk sport" in much of the research literature. Both "high risk" and "extreme sport" are defined as any "sport where one has to accept a possibility of severe injury or death as an inherent part of the activity" (Breivik et al., 1994). In the same manner, classification of extreme or high risk could partly be due to peak static and dynamic components achieved during competition (Mitchell et al., 2005), which may result in bodily changes such as high blood pressure (e.g., Squash vs. Archery). A further classification would consider physical risk

(e.g., BASE Jumping vs. Darts) as a defining feature of any "extreme or high risk sport" (Palmer, 2002). However, the implication that those who engage in extreme sport are exclusively high-risk taking participants is an over simplification which requires careful consideration. Part of the difficulty in being able to define extreme sport is, according to Kay and Laberge (2002). There are so many contradictory factors aside from risk. It is suggested here that there are spatial, emotional, individualistic and transgressive dimensions to consider in these sports. Terms such as "alternative," "action," "adventure," and "lifestyle" are also used to describe extreme sport, however, none of these terms categorically encompass what extreme sport actually entails.

WHAT IS EXTREME?

According to Merriam-Webster's online dictionary (retrieved September 2018) the word extreme means: (1) Exceeding the ordinary, usual or expected. (2) Existing in a very high degree. (3) Going to a great or exaggerated lengths. Therefore, extreme as used in "extreme sport" suggests a deviation beyond what is generally viewed as "normal" or "traditional" activity and assumes participants pursue activities beyond these limits. The online Oxford University Dictionary (2018) defines "extreme sport" as "Denoting or relating to a sport performed in a hazardous environment and involving great risk." So, the concept of "going beyond normal limits" and "risk" seem integral to what constitutes extreme sport. Booker (1998) stated that "extreme sports" were beyond the boundary of moderation; surpassing what is accounted for as reasonable – i.e., radical, and sports that are located at the outermost. Breivik et al. (1994) defined extreme sport' as a high-risk sport where the possibility of severe injury or death is a possibility as well as integral to the sport or activity. So, the components of these definitions include: going beyond the norm of what is considered reasonable and may result in severe injury or death, i.e., high physical and/or psychological risk.

WHAT IS SPORT?

Historically the definitions of sport have evolved particularly as new activities such as "BASE jumping" and "extreme mountain ironing" have emerged to challenges the perception of what sport actually is. Eysenck et al. (1982), in their seminal review paper began by highlighting the problems inherent in the definition of sport. They used the Collins dictionary in their paper to define sport as amusement, diversion, fun, pastime, game. . . individual or group activity pursued for exercise or pleasure often involving the testing of physical capabilities. . . (Eysenck et al., 1982). Arguably, this type of definition is overly inclusive, incorporating activities of amusement and pleasure whereby virtually anything that is non-work could be considered sport.

A more recent definition of sport is "all forms of physical activity which, through casual or organised participation, aimed at expressing or improving physical fitness and mental well-being, forming social relationships or obtaining results in competition at all levels" (Council of Europe [CEE], 2001, The European Sports Charter, revised, p. 3 – CEE). This broad definition of sport can encompass "traditional" sports such as Archery, Football, and Cricket, as well as those hitherto regarded as extreme sports such as Drag racing, BASE Jumping and Snowboarding.

Historically the CEES's definition is not entirely new as sport has traditionally been accepted to represent a competitive task or activity engaged in by an individual or a group, which requires physical exertion and is governed by rules. Mason (1989) saw sport as "a more or less physically strenuous, competitive, recreational activity. . .usually. . .in the open air (which) might involve team against team, athlete against athlete or athlete against nature, or the clock." Sport is generally viewed to be performed by individuals or in a group, as an organised, evaluative activity where the outcome of performance is judged by winning or losing. However, the inclusion of the word "or" in the CEES definition changes the nature of what is considered to be sport. It implies that results in competition do not need to be present and can be self evaluative or competitive. The modification of this definition allows activities such as recreational swimming or bungee jumping to now be classified as sports.

IS "EXTREME SPORT" THE SAME AS "HIGH RISK SPORT?"

If "extreme sport" is the same as a "high-risk" sport then those individuals that engage in these sports should be at greater risk of injury or even death than those engaging in traditional sports (Yates, 2015). When investigating the available statistics relating to extreme sport, one comes across a minefield of contradictions as the classification of injuries and/or fatalities are reported in a myriad of different ways.

A further challenge is then to set parameters using statistics of extreme sport according to risk, injury or mortality. This would require traditional sports such as cheerleading and horse riding, due to their high annual incidence of catastrophic injuries, to be classified as high-risk sports (Turner and McCory, 2006). In the United Kingdom the Rugby Football Union defined injury as something that ". . .prevents a player from taking a full part in all training activities typically planned for that day. . ." (p. 7 in the England Professional Rugby Injury Surveillance Project Season, 2013–2014). Mean injuries per match for 2013 were identified as 62 and mean injuries per club (including training) were 35 (p. 6 England Professional Rugby Injury Surveillance Project Season, 2013–2014). Annual Rugby Union incidents around the world account for 4.6 catastrophic injuries per 100,000 each year, e.g., the risk of sustaining a catastrophic injury in Rugby Union in England (0.8/100,000 per year) are relatively lower than in New Zealand (4.2/100,000 per year), Australia (4.4/100,000 per year), and Fiji (13/100,000 per year). The risk of sustaining a catastrophic injury in other contact sports are; Ice Hockey (4/100,000 per year), Rugby League (2/100,000 per year), and American Football (2/100,000 per year) (Gabbe et al., 2005; Fuller, 2008).

Besides mortality as a relevant and possible outcome, the link between the "extreme" nature of sport and brain damage arguably should be considered. Recently, the association between contact sports such as American Football and Rugby, combat sports such as Boxing and the team sport of Soccer (which includes heading balls), has resulting in a raised awareness of the relationship between sport and brain injuries and/or cognitive disturbance such as that found in Dementia. Negative effects on neuro-functioning in terms of cerebral blood flow, resulting in poor cognitive performance, can be prevalent in several sports, e.g., there have been recommendations from scuba diving research which suggested that scuba diving should be classified as a high-risk sport for the purpose of subjecting it to tighter controls and increased medical advice (Slosman et al., 2004). Alternative research suggests that classifying a sport as "extreme" should be based solely by mortality rate (Schulz et al., 2002). Mortality figures (see **Table 1**) show that whilst BASE Jumping has an extremely high mortality rate so does boxing and, somewhat surprisingly, canoeing. One may argue that employing such methods to classify sports is anything but straightforward, moreover many of the sports currently viewed as "traditional" may need further consideration as to how they could fit into a proposed working definition of extreme sport.

Besides physical risk May and Slanger (2000) suggest there is potentially psychological risk when engaging in high risk sport. Their findings suggest such activities can be psychologically damaging leading to elevated stress levels, extreme competitiveness and excessive perfectionism. In view of this it could be pertinent to consider the tenets of high-risk sport as both physical and psychological. In a somewhat provocative statement, Slanger and Rudestam (1997) cited extreme sport as an expression of a death wish, whereby in a slightly different manner, Brymer and Oades (2009) considered extreme sport not to be about the expression of risk but rather about the experience of approaching danger. It is also evident that many researchers conducting studies into sensation seeking have used the term "high-risk" interchangeably with "extreme sport" (e.g., Cronin, 1991; Gomàl Freixanet, 1991; Breivik et al., 1994; Wagner and Houlihan, 1994).

Extreme sport has also been viewed as a contradiction to "normal" behaviour, which generally seeks safety and avoids high-risk (Fletcher, 2004). The idea that participants choose to "accept the possibility" of injury or death (Breivik, 1996) contradicts theories such as Maslow (1987) which stress that safety is a primary, innate need. Baudry (1991) writes that extreme sport is paradoxical in nature, as it requires one to contest his/her mortality through a strategy of premeditated suicide. This challenges normative thinking as it infers that extreme sport goes beyond official regulations and safety precautions and can purposefully place the participant in a potentially fatal situation. It implies that extreme sport is dangerous, unregulated and could arguably involve breaking laws or safety regulations, e.g., trespassing is often intrinsically linked to the sport of BASE jumping.

High Risk is a key concept in the definition of extreme sport and therefore **Table 1** includes the component of risk of injury and mortality related to a range of sports. High risk is often used interchangeably with extreme sport.

Although terms such as Whiz (Midol, 1993), Post-modern, Post-industrial, New sport, Unconventional, and Non-traditional and Panic sport, have been used in the past (Rinehart and Sydnor, 2003) the most prevalent terms perceived as representing extreme sport which are subsequently outlined in this review, are: Alternative, Action, Adventure, Lifestyle, Media Driven, and Individualism.

IS "EXTREME SPORT" JUST AN "ALTERNATIVE SPORT" TO "TRADITIONAL SPORT?"

In North America, the word "alternative" is popularly used to denote any sport not American (Humphreys, 1997; Rinehart and Sydnor, 2003) whereas researchers such as Kay and Laberge (2002) have used the term "alternative sport" in a more universal way to describe sports which are non-traditional sports. The difficulty in using this term as an all-encompassing word for extreme sport is that many sports are "alternative" as they challenge the societal concept of what is the norm but not all "alternative" sports are extreme (Jarvie, 2006). Arguably then the term "alternative" can be merely a transient term until the "alternative" sport becomes mainstream, thus conventional. For example, Howe (1998) suggests that alternative sport depends on the masses for its continued existence, for once alternative sport becomes commercial and popularised by the public it becomes mainstream. Rinehart and Sydnor (2003) recognise this as an irony as they acknowledge that what is alternative quickly becomes conventional so a dynamic definition of extreme sport, due to perceptual changes, would be needed. Arguably then, in view of this, the term "extreme sport" is therefore considerably more accurate than the widely used term "alternative sport."

IS "EXTREME SPORT" THE SAME AS "ACTION" OR "ADVENTURE" SPORT?

"Action" sports are an assortment of "risky, individualistic and alternative sports such as skateboarding, BMX biking, surfing, street luge, wakeboarding, and motor cross" (Bennett and Lachowetz, 2004). Griffith (2002) explores the definition of action sports as something that has evolved from the broader sporting culture of surfing, skating, snowboarding and wakeboarding. Advertising companies employ the term as an effective association in creating a "cool" desirable, brand.

Winged suit jumper Chris "Douggs" McDougall prefers the term "adventure sport" to "extreme sport" because every time he participates he feels that he is going on a cool adventure (O'Neil, 2017). The term adventure sport is used a great deal commercially. The Mintel Report (2003a) noted a division in the reporting of sporting holidays as either hard or soft adventure, whereby "hard" adventure holidays promote risk, danger, challenge and an adrenalin rush. These types of holidays offer caving, mountaineering, white water rafting and skydiving.

Adventure sport may be a commonly used term amongst holiday promoters as the words themselves denote excitement and fun. Adventure sports also depict lifestyle sports as they are a leisure time pursuit with not only physical, but also mental exercise. They are journeys through which participants face their own limits of fear, exhaustion and risk, however, they are based more on individual achievement than many traditional sports. For example, the competition element between individuals could be lacking though it is evident that "competition" may exists between the participants and their environment. Adventure sport is a term commonly used in the tourism industry, however, when searching for a universal term for the sake of academic research it is limiting as sports such as BASE jumping or Stunt Cycling or Drag Racing would not readily fit into this category.

The key term, *natural environment* emanating from action and adventure research is another component placed in **Table 1** so that the researchers could see whether there is a pattern of words which emerge to formulate the start of definition and this academic debate. In addition, the idea of competition versus self-evaluation found in the above literature was also included.

IS "EXTREME SPORT" JUST A LIFESTYLE SPORT?

The term "lifestyle sport" as utilised in the Mintel Report (2003b) identifies specific sports through an examination of the link between the participants, the activity and the environment. Their popularity represents a bottom-up approach steeped in grass root participation that is welcoming to all who want to participate. Those who have been alienated by traditional school-based and institutional sport are often attracted to lifestyle sports (Wheaton, 2004). Affiliation provides participants with membership into an exclusive club – which includes equipment, clothes, like-minded people, books and web sites and can create a social group and sub-culture. In essence, it is sharing the enthusiasm for sport with others who share the same passions and yearn for the same excitement. There are commonalities between "Lifestyle" and "Extreme" sports whereby participants have a sense of camaraderie as they learn from each other via a dress code (e.g., Surfers, Skiers, Skateboarders), specialist web sites as well as the need for specialised equipment.

Tomlinson et al. (2005) considered the "lifestyle" definition to be ambiguous and problematic. They described lifestyle as a way in which individuals interpret their lives for themselves and for others. Using that definition to distinguish between sports would require a differentiation between each person's motivations for participation in sport. Lifestyle sports relate to those sports pertaining to individual or personal factors. It is more of a descriptor than an encompassing way to describe a variety of sports. Those that do undertake extreme sport, however, may agree that participation in extreme sport does become a lifestyle of sorts when they are with others who are also engaging in their sport.

Alternatively, high risk can refer to spatial dimensions, based on "extreme locations – wilderness, remoteness, the forbidden" (Tomlinson et al., 2005). Sport where participants compete with the natural elements in locations with snow, hills, canyons, islands, mountains, rivers, or volcanoes would fit into the category of "high risk" sport, e.g., extreme skiing and white water rafting. As mentioned previously these are also sometimes referred to as "adventure" sports. Brymer and Oades (2009) labelled "high risk" sport as being undertaken in the natural environment, however, not all "high risk" sports meet this criterion. BMX, Drag Racing and Big Air Snowboarding, for example, take place on a man-made track and Skateboarding can be performed inside or outside and may involve a ramp designed and manufactured specifically for the performance of sport. So although performance in a natural environment is true for some

TABLE 1 | Categorising extreme sport.

Descriptive components	1. Competitive or self evaluative	2. Natural environment (speed, height, depth, natural forces)	3. High risk evidenced by mortality statistics
Extreme sport			
Archery	Yes	No	No
Base jumping	Yes	Yes	1:60
Basketball	Yes	Not really	No
Boxing	Yes	Some speed	1:2,200
Canoeing (white water canoeing)	Yes	Yes	1:10,000
Cycling	Yes	Not really	1:140,845
Drag racing	Yes	Yes	484 deaths 2010–2016*
Grand prix racing	Yes	Yes	1:100
Hand gliding	Yes	Yes	1:560
Motor cycle racing	Yes	Yes	1:1000
Mountain climbing	Yes	Yes	1:750
Scuba diving	Not necessarily	Usually	1:34,400
Snow boarding	Yes	Yes	1:2.2 million
Soccer	Yes	Not really	No
Swimming	Yes	Somewhat – e.g., open water endurance	1:1 million

"high risk" sports and could be true for many extreme sports it is not categorically accurate for all extreme sports.

IS "EXTREME SPORT" MEDIA DRIVEN TERMINOLOGY?

So is extreme sport merely a new term for high-risk sport and if so where did the term "extreme sport" emanate from? Arguably what constitutes extreme sport has been predominantly media led (Kay and Laberge, 2002), whereby the term extreme sport has been based on the sale-ability in promoting non-traditional sport to the media and for the increase in consumerism and corporate interest. Sponsorships, endorsements, TV marketing and advertising all utilise the term "extreme sport" for these reasons. For example, the 2014 Winter Olympics became the first games to classify such events as Snowboarding, Ski Jumping, Freestyle Skiing, Skeleton, Luge, Kayaking, and Windsurfing under "extreme sport" umbrella. The 2018 games included as extreme sport events Big Air Snowboarding, Mixed Alpine Skiing, and Mass Start Speed Skating. The 2020 Olympic games in Tokyo has approved the inclusion of the extreme sports of surfing, rock climbing and skateboarding (Herreria, 2016). Adaptive sport is pursuing extreme sport as a cultural norm with the characteristics of increasing heart rate, adrenalin rush, and action sport (Denq and Delasobera, 2018). Interestingly, the term "extreme sport" is probably the most prevalent term used in the media for these types of sports.

DOES "EXTREME SPORT," INCLUDE A COMPONENT OF INDIVIDUALISM?

"Extreme sport" can be a way of striving for self-actualisation. Those who are self-actualised according to Maslow (1987) have a sense of self-acceptance and the thrill in living for the moment. Researchers examining these terms for "extreme sport" have focused on the psychological motivation the participants need to find "self-actualisation and spiritualism" (Borden, 2001), promote a "positive personal change" (Brannigan and McDougall, 1983) or fulfil the desire of a "powerful life wish" (Brymer and Oades, 2009).

Robinson (1992, p. 99) viewed "extreme sport" as an activity based on both cognitive and emotional components, as a "a variety of self-initiated activities that generally occur in natural-environment settings and that, due to their always uncertain and potentially harmful nature, provide opportunity for intense cognitive and affective involvement." Tomlinson et al. (2005) also recognised an "emotional dimension" within "extreme sport" which can be identified as a sensation of wholeness. This is akin to the concept of flow which Csikszentmihalyi (1975) described as a conscious state of being completely absorbed in a situation or sport. The sense of elation and peace experienced in "extreme sport" may be the result of a rush of adrenalin and release of endorphins, which are endogenous mood enhancers.

Puchan (2004) suggests that underlying the growth of "extreme sports" are societal factors such as computer games and various websites designed to promote excitement and/or fear. These cultural changes within particular areas of society encourage individuals to test themselves against great odds without having to leave the parameters of their home. However, in an effort to escape what Puchan (2004) calls boredom and mediocrity, individuals search for outlets where the self can be rediscovered. The concept of "extreme sport" as an answer to boredom fits in with the notion of boredom as a factor in Zuckerman's (1994) subscale of sensation seeking.

Thrill seeker sports participants are typically 24–34 year old males, single and 80% are without children (Sport England, 2015) therefore one could argue that they have ample spare time and are bored with life? Griffith (2002) sees the market of extreme sport as being youth oriented, as a sport that doesn't require a group or team and therefore open to anyone who wishes to participate. Moreover if "extreme sports" were predominantly youth oriented, then this term makes an immediate assumption that those who participate are all younger adults which is not the case. Most extreme sport participants are on average aged around 30–31 years: e.g., in Triathlon (off road) the average age is 31 years, Windsurfing 30 years and Sport Climbing 30 years (Outdoor Participation Report, 2013). The latest figure by the Outdoor Foundation Topline Report produced by the Physical Activity Council (2016) shows that 56% of all those that participate in outdoor activities are aged between 15 and 44 years. Clearly, from a developmental perspective, this age group is in a period of transition from adolescence into adulthood, therefore arguably there may be an individualistic nature to extreme sport. Moreover it could be viewed in some instances as a modern rite of passage (Groves, 1987). Perhaps part of the appeal of extreme sport is due to its' challenging nature at a period (in western culture) when the uncertainty of adulthood is approaching, thus further supporting the argument for a strong self or narcissist focus.

Wheaton (2004) discussed this narcissistic focus as a need for isolation. So while, in many cases, traditional sports promote the ideal of teamwork, extreme sports are focused on individual goals: a more personalised way of challenging oneself without an organised winning or losing concept. Here the emphasis is mostly on self-competition through personal challenges and the idea of just "doing it" (Tomlinson et al., 2005). Arguably, for this reason the term "extreme sport" is often synonymous with "individualistic sport" (Puchan, 2004), whereas traditional sport focuses on the challenge of competition, extreme sport focuses on individual achievement.

CONCLUSION AND IMPLICATIONS

From a scientific perspective there are difficulties when setting out to examine extreme sport due to a lack of consensus on the tenets of extreme sport. One of the aims of this article was to contribute to the literature on extreme sport and enhance the academic debate prescribing a new workable definition for the sporting literature. However, this objective has been problematic as the definition of extreme sport is ill-defined due mainly to a variety of terms having been used interchangeably with little

scientific evidence in support, namely extreme, alternative, high risk, action, and lifestyle sports. This lack of consistency in terminology means that those wishing to study this field are forced to create their own criteria as a starting point, often in a less than scientific approach. As definitions are important to the start of evidenced based research or argument, this article focused on examining the terminology commonly used to represent what is generally perceived as "sporting activities outside of the norm" in order to distinguish between the various terms.

When examining the available research, it also became evident that a variety of interchangeable terms are used by the media, e.g., high-risk sport, adventure sport, alternative sport, lifestyle sport, and action sport as well as extreme sport. These terms have been identified and are in use according to the Mintel Report (2003a) on "Sport Activity in the United Kingdom." Interestingly, each definition or synonymous term also contains components that give insight into the personality and the motivation of "extreme sport" participants. For example, adventure sport infers challenge along with uncertainty, whilst lifestyle sport implies camaraderie.

Tomlinson et al. (2005) concluded that there were "no universally agreed terms to describe the sports (extreme sports), no agreed categorisations through which to order and understand them and little in the way of governance structures to regulate them" (p. 5). Yet extreme sport, because it has yet to be fully defined, has, to some extent, been a created by the media complete with a "marketing strategy, an ethic, a vocabulary, an attitude, and a style" (Kay and Laberge, 2002).

This article proposes another way in which the term "extreme sport" may be considered so that ambiguity within research is reduced in the future. Specifically we argue that "extreme sport" is a predominantly competitive (comparison or self-evaluative) activity within which the participant is subjected to natural or unusual physical and mental challenges such as speed, height, depth, or natural forces. Moreover, an unsuccessful outcome is more likely to result in the injury or fatality of the participant more often than in a "non-extreme sport." Therefore, it is suggested that incidents of injury/fatality are the defining factors that separate extreme sports from other sports which would fit into the alternative categories listed, i.e., adventure sport, alternative sport, lifestyle sport and action sport. High-risk sport immediately evokes a sense of danger and extremism, activities similar in nature to extreme sport. In this case, for the purpose of scientific investigation, it is suggested that the term "high risk" is not abandoned but that the use of the current new definition proposed incorporates it within a fuller richer definition of Extreme/High Risk Sport.

Extreme or High Risk sport is one of the fastest growing areas in sporting activity this century, due to its nature it attracts the interest of the media worldwide yet, in the context of sport science, it's definition needs to be needs to be conceptually clear and linguistically accurate and not influenced by terminology promoted by the media. If our scientific endeavours are to be reliable and valuable then our parameters under investigation need to be consistently, clearly defined. A clear definition of "extreme/high risk sport" as contained in this review, employing a system categorised on the number of injuries/fatalities with a sport is, arguably, a solid basis on which to drive the scientific process for future research forward.

LIMITATIONS AND FUTURE RESEARCH

A limitation of this research is that we have neither discussed nor differentiated between extreme sport as a "sport" or an "activity" furthermore, between recreational or non-recreational as in CEES. Future research will be undertaken to examine a wide range of sports in order to devise a classification system, which ranges from traditional to extreme/high risk sport according to the current working definition which may be based on injury/fatality per capita for each sport in relation to general risk. Indeed, a recent study by Cohen et al. (2018), has shown significant differences in personality traits between athletes engaged in extreme sport (drag racing) and traditional sport (archery). Personality traits are now playing a significant role in the psychological models of rehabilitation and predicted outcomes (Pain and Kerr, 2004). Future research should capitalise on the distinctions made in the present study in examining the role of personality in sport injury and rehabilitation.

Ongoing research conducted by the current authors includes interviewing and surveying those who participate in extreme sport as well as those who don't participate, in order to gain insight for future directions, with an immediate aim to ascertain where specific sports may lie on a continuum of sports ranging from traditional to extreme/high risk. **Table 1** is a start on examining the categories of risk, extremes in nature (e.g., height, speed, depth) and (elements of the sport definition – competitive, evaluation) being proposed in the definition for extreme sport. The authors will further expand on any arising variables that have not yet been under consideration and on completion of our follow up work the aim is to develop a formula which enables the aspects of each sport to be analysed according to the current working definition, hence enabling evidence based inclusion on a sporting continuum.

A final recommendation is for subsequent researchers to examine sporting categories in line with the current working definition thus building a corpus of evidence by which the debate around what is extreme/high risk can be scientifically judged. This will enable an advance not only into the field of extreme/high risk sport but in sport science research in general.

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All authors approved the manuscript for publication and agreed to be accountable for all aspects of the work.

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Self-Transcendence in Mountaineering and BASE Jumping

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The "extreme sports" of mountaineering and BASE Jumping are growing in popularity and are associated with significant risk of injury and death. In recent years there have also been increasing numbers of reports of reckless disregard and selfishness in the pursuit of mountaineering goals, including severe environmental degradation. Extant research has focused predominantly on personality variables that contribute to engagement, participation, and stress responsivity in these extreme sports. The Temperament and Character Inventory (TCI) provides a comprehensive account of personality traits, measuring seven dimensions of personality that are moderately heritable and associated with distinct brain networks and psychological characteristics. One of these traits is Self-Transcendence, which is associated with spiritual ideas and experiences, such as searching for something elevated and greater than one's individual self. High Self-Transcendence can motivate people to act altruistically even if that requires personal sacrifices and hardship. This article draws on the extant research literature, which has consistently found that despite substantial heterogeneity in their individual personality profiles, mountaineers, and BASE jumpers are adventurous in temperament and highly self-controlled and organized in character. Between 75 and 85% of the character configurations observed in these populations are associated with low Self-Transcendence. The purpose of this paper is to consider the role of Self-Transcendence and its effect on individual personality profiles of extreme athletes, in particular in moderating potentially self- destructive, and regressive ethical and moral behaviors in mountaineering and BASE jumping.

Keywords: self-transcendence, mountaineering, BASE jumping, personality, temperament, character, elite performance

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INTRODUCTION

"Extreme sports" are a diverse group of sporting activities, including mountaineering and BASE Jumping, which require very high levels of skill and are physically and mentally demanding. They are associated with high risk of injury and death (Monasterio, 2005; Mei-Dan et al., 2012, 2013). Paradoxically despite these well-documented risks there has been a rapid growth in interest and participation in these sports, far more so than traditional sports, over the past 20 years (Pain and Pain, 2005).

Arguably mountaineering is the extreme sport that has been practiced the longest. Traditional mountaineering values were shaped around the concept of "the brotherhood of the rope," which emphasized the values of fellowship, mutual support and self-sacrifice. For example, in 1953 during an attempt to be the first to climb K2, the notoriously dangerous second highest peak in the world, Dr. Charlie Houston and 6 teammates battled exhaustion, atrocious weather and frostbite to rescue a critically sick companion, Art Gilkey, from the upper reaches of the mountain. They were within reach of the summit but instead they dedicated all their energy to a harrowing rescue effort. They repeatedly put their lives at risk and survived arguably the most famous fall in mountaineering history after an ice ax belay from one of the party prevented them all from plummeting down a steep slope to their deaths. Gilkey was subsequently lost in what was assumed to be an avalanche, although Dr. Houston believed Gilkey ended his own life by cutting safety lines attaching him to the mountain to spare further risk to the team (Martin and Charles, 2009).

In August 2008 during the worst single accident in the history of K2 mountaineering a solo Sherpa, Pemba Gyalje, took enormous risks as he repeatedly climbed back up the mountain to search and rescue injured climbers. Before launching on the rescue missions Pemba had already climbed the mountain and survived a difficult and traumatic descent through the night after an ice tower ripped safety lines near the summit (Bowley, 2011).

In contrast, during recent years there have been increasing numbers of reports of climbers showing apparent disregard for the safety and suffering of sick climbers, and selfishness in the pursuit of mountaineering goals, including behaviors contributing to severe environmental degradation (Apollo, 2014, 2016). This suggests that traditional values are in some instances being subordinated by blind ambition, indifference to human suffering, and faulty leadership (Kodas, 2008). A widely reported controversial event on Everest (Sagamartha) in 2006 is an example. Over 40 ascending climbers, most with significant team back-up and radio contact to base camp, walked past a dying English mountaineer, David Sharp, as he sat collapsed and stranded 1 h from advanced high camp. Although climbing teams were well-equipped with modern equipment, oxygen and medicine, no significant medical assistance was given and no rescue attempts were made. Film footage of the unfortunate climber was taken, showing that David was able to speak despite his poor health status. All mountaineers walked around David and continued toward the summit (Breed and Gurubacharya, 2016)[1]. This led many to question whether some mountaineers place more value on a successful ascent of Everest than on the life of a fellow climber (Kodas, 2008).

It has also been reported that in 2004 a mountain guide, Gustavo Lisi, left his 69 year-old altitude-sick and delirious client, Dr. Nils Antezana, on the summit ridge of Everest. After descending to safety Lisi not only allegedly failed to raise the alarm about his client's plight but also posted news of his successful climb. Dozens of other climbers walked past the dying Dr. Antezana on their descent from the summit. The body of Dr. Antezana was lost to the mountain. It is presumed he fell to his death (Kodas, 2008). Pulitzer Prize–winning journalist Kodas has written a book with a disturbing number of similar accounts of "… a new breed of parasitic and predatory adventurer."

Another extreme sport that is experiencing increasing morbidity and mortality is BASE jumping, which is arguably the most dangerous of the "extreme" sports (Mei-Dan et al., 2012, 2013). BASE jumping developed out of skydiving and uses specially adapted parachutes to jump from fixed objects. "BASE" is an acronym that stands for the four categories of fixed objects that one can jump off. These are: **B**uilding, **A**ntenna, **S**pan (a bridge, arch, or dome), and **E**arth (a cliff or other natural formation). It has been legally prohibited in many areas, most recently in Chamonix, France after a wingsuit BASE jumper crashed into a chalet potentially putting others at risk (Bisharat, 2017).

Monasterio and associates have examined the role of personality in extreme athletes with the Temperament and Character Inventory (TCI). The purpose of these studies has been to identify personality factors that may contribute to participation, accidents, and stress reactivity in mountaineers and BASE Jumpers (Mei-Dan et al., 2013; Monasterio et al., 2014, 2016).

The purpose of this paper is to hypothesize on the role of Self-Transcendence and its effect on individual personality profiles, in particular in moderating potentially self- destructive and regressive ethical, and moral behaviors in extreme sports. Beyond the research data presented, the proposed hypothesis is influenced by the experience of one of the author's (EM) who has extensive experience of "extreme sport" culture. EM has been involved in high-performance mountaineering, exploration and guiding for over 30 years. Reports of increasing death rates despite awareness of the risks among BASE jumpers are concerning. Furthermore, as indicated by the anecdotal examples already described, there are indications that in their pursuit of a summit some mountaineers can resort to unethical and at times criminal behaviors, whereas others adhere to the highest ethical standards and risk their life in the service of others.

SELF-TRANSCENDENCE

Self-Transcendence (ST) is a trait associated with spiritual ideas and experiences, such as searching for something elevated and greater than one's individual self. ST is characterized by the direct perception of participation in something greater than one's self or perhaps even something boundless (Cloninger et al., 1993). Such a feeling of connectedness is a source of such joy and satisfaction that it can motivate people to act altruistically, even if that requires personal sacrifices and hardship, as exemplified by the honorable mountaineers already described here. Highly self-transcendent people have an outlook of unity and connectedness that motivates them to work in the service of others, instead of being preoccupied with individual accomplishments and self-aggrandizement (Cloninger et al., 1993).

[1]Turkish climbers about David Sharp: "He was not part of a team." Posted on explorers 479 web 5.6.2006 http://www.explorersweb.com/everest_k2/news.php?id=10049

TABLE 1 | Descriptors for high and low scorers on TCI subscales (Monasterio et al., 2016).

TCI scales	TCI subscales	High scorers	Low scorers
Novelty-seeking	NS1 excitability	Exploratory	Reserved
	NS2 impulsivity	Impulsive	Rigid
	NS2 extravagance	Extravagant	Thrifty
	NS4 disorderly	Rule-breaking	Orderly
Harm-avoidance	HA1 pessimism	Pessimistic	Optimistic
	HA2 fearfulness	Fearful	Risk-taking
	HA3 shyness	Shy	Outgoing
	HA4 fatigability	Fatigable	Vigorous
Reward- dependence	RD1 sentimentality	Sentimental	Objective
	RD2 sociability	Open	Secretive
	RD3 attachment	Friendly	Detached
	RD4 dependence	Approval-seeking	Independent
Persistence	PS1 eagerness	Enthusiastic	Hesitant
	PS2 hard-working	Determined	Easily discouraged
	PS3 ambition	Ambitious	Lazy
	PS4 perfectionism	Perfectionistic	Underachieving
Self-directedness	SD1 responsibility	Responsible	Blaming
	SD2 purposefulness	Purposeful	Aimless
	SD3 resourcefulness	Resourceful	Helpless
	SD4 self-acceptance	Hopeful	Hopeless
	SD5 self-actualizing	Self-actualizing	Unfulfilled
Cooperativeness	CO1 social tolerance	Tolerant	Prejudiced
	CO2 empathy	Empathetic	Self-centered
	CO3 helpfulness	Considerate	Hostile
	CO4 compassion	Forgiving	Revengeful
	CO5 conscience	Principled	Opportunistic
Self-transcendence	ST1 self-forgetfulness	Acquiescent	Controlling
	ST2 transpersonal identification	Altruistic	Individualistic
	ST3 spiritual acceptance	Spiritual	Skeptical

CLONINGER'S TEMPERAMENT AND CHARACTER INVENTORY (TCI)

The TCI provides a comprehensive account of personality traits, measuring seven dimensions of personality (see **Table 1**) that are moderately heritable and associated with distinct brain networks and psychological characteristics (Cloninger, 1987; Cloninger et al., 1993; Gillespie et al., 2003; Van Schuerbeek et al., 2011). The model measures four dimensions of temperament (see **Figure 1**), which involve basic emotional drives modulated by the hypothalamus and related limbic structures (Lennox and Dolan, 2014), and three character dimensions (see **Figure 2**), which involve self-regulation of emotions and attention in order to achieve intentional goals and values regulated mainly in the neocortex (Cloninger, 1987; Cloninger et al., 1993; Gillespie et al., 2003; Van Schuerbeek et al., 2011). For example, high Self-Directedness is related to the executive attention system involving bipolar neurons in the anterior insula, frontal operculum, and anterior cingulate (Posner and Rothbart, 2007; Allman et al., 2011; Van Schuerbeek et al., 2011). Low Harm-Avoidance is associated with reduced functional connectivity in the insular salience network (i.e., right anterior insula with anterior cingulate and dorsolateral prefrontal cortex) (Paulus et al., 2003; Markett et al., 2013). Higher Novelty-Seeking and lower Harm-Avoidance are associated with larger volumes of cerebellar white matter and cortex bilaterally (Petrosini et al., 2015). Higher Novelty-Seeking scores are related to larger caudate and pallidum volumes bilaterally whereas lower Harm-Avoidance is related to reduced diffusivity in the putamen as measured by diffusion tensor imaging (Laricchiuta et al., 2014).

Extensive data on the reliability and validity of the TCI have been reported, and the TCI has been shown to have sound psychometric characteristics (Cloninger et al., 1993).

MORBIDITY, MORTALITY, AND TCI RESULTS IN MOUNTAINEERS AND BASE JUMPERS

The methodology and findings of these studies are reported in the literature (Monasterio, 2005; Mei-Dan et al., 2012, 2013; Monasterio et al., 2014, 2016). All participants volunteered their participation and were recruited from Alpine Club and BASE Jumpers group meetings and social media platforms, as well as personal communication among these sport communities. The mountaineers study specifically included only subjects who regularly engaged in climbing with a high level of technical proficiency. Ninety-five percent of mountaineers had more than 5 years climbing experience and 60% more than 10 years, with a median alpine grade of V+ (expert level) (Monasterio et al., 2014). BASE Jumpers had median participation rates of 6 years with >250 jumps (Mei-Dan et al., 2013; Monasterio et al., 2016).

The findings on average are consistent across all studies (refer to **Table 2**); these populations are adventurous in temperament with the "right stuff" (high Novelty-Seeking, low Harm-Avoidance, and Reward-Dependence) compared to low-risk sports participants and the general population. They are also highly self-controlled and organized in character (high in Self-Directedness and Cooperation, and low in Self-Transcendence). However, there is substantial heterogeneity in their individual personality profiles (Mei-Dan et al., 2013; Monasterio et al., 2014, 2016). Different configurations of temperament and character are illustrated in **Tables 3**, **4**, respectively. These personality configurations vary in both their pattern of stress reactivity, resilience, and in their goals and values (Monasterio et al., 2016). Seventy five percent of the character configurations observed in BASE jumpers were associated with low Self-Transcendence (Monasterio et al., 2016). Likewise 85% of the character configurations in mountaineers were associated with low Self-Transcendence (Monasterio et al., 2014).

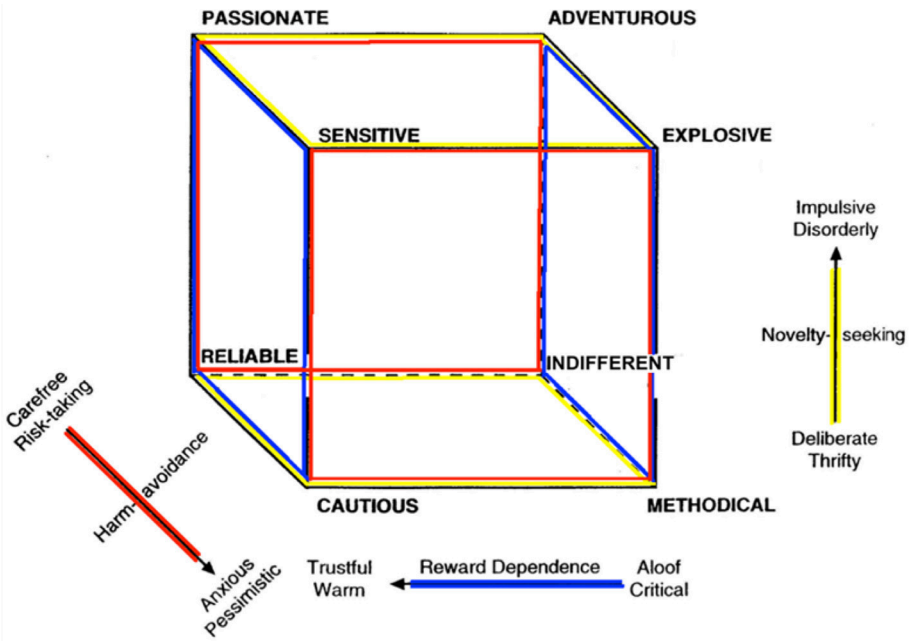

FIGURE 1 | The Temperament Cube (Cloninger, 1987).

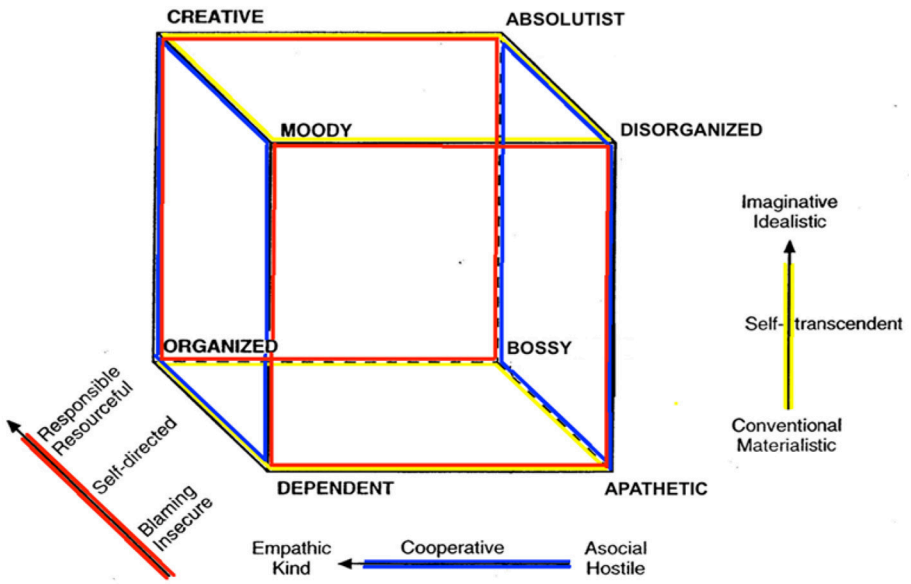

FIGURE 2 | The Character Cube (Cloninger et al., 1993).

DISCUSSION

The authors have utilized the TCI to identify important aspects of personality that contribute to participation and performance in expert level mountaineering and BASE Jumping. The TCI deconstructs personality into temperament and character dimensions that are composed of seven traits that vary widely in the general population. The range of configurations of these traits gives rise to a wide range of personality styles that are well-described in the literature (Cloninger, 1987). The study populations have adventurous personality profiles with organized character structure. The vast majority (85%) are considerably lower than average in Self-Transcendence, so we have focused on understanding the implications of this strong relationship in this

TABLE 2 | Climber ($n = 47$), BASE jumper ($n = 68$), and Normative population ($n = 181$) TCI-235 score means (and SD).

	NS**	HA***	RD**	*P*	*SD***	C	ST***
Climbers	21.36 (5.2)	9.1 (4.8)	14.1 (4.4)	5.0 (1.5)	35.5 (5.1)	34.1 (4.6)	11.2 (6.8)
BASE J.	22.8 (5.7)	7.9 (6.3)	13.8 (4.8)	5.5 (1.4)	33.4 (6.7)	33.7 (5.6)	12.7 (7.0)
Population	19.0 (5.8)	12.4 (6.9)	15.6 (4.3)	5.7 (2.1)	32.0 (7.0)	33.6 (6.7)	18.7 (6.3)

*Monasterio et al. (2012, 2014). **$p < 0.05$; ***$p < 0.001$. NS, Novelty Seeking; HA, Harm Avoidance; RD, Reward Dependence; P, Persistence; SD, Self Directedness; C, Cooperativeness; ST, Self Transcendence.*

TABLE 3 | Distribution of BASE jumper temperament profile types ($n = 98$) (Monasterio et al., 2016).

Profile type	Configuration	Number	Cumulative %
Adventurous	Nhr	36	36.7
Passionate	NhR	18	55.1
Independent	nhr	14	69.4
Explosive	NHr	8	77.6
Methodical	nHr	8	85.7
Reliable	nhR	8	93.9
Cautious	nHR	4	98.0
Sensitive	NHR	2	100.0

TABLE 4 | Distribution character configurations in Base jumpers ($n = 98$) (Monasterio et al., 2016).

Profile type	Configuration	Number	Cumulative %
Organized	SCt	43	43.9
Creative	SCT	18	62.2
Bossy	Sct	12	74.5
Apathetic	sct	10	84.7
Disorganized	scT	7	91.8
Dependent	sCt	4	95.9
Moody	sCT	3	99.0
Absolutist	ScT	1	100.0

article rather than the role of risk-taking that is more obvious. Extensive work on personality, risk-taking, executive attention, and brain circuitry have been extensively investigated (see earlier section: Cloninger's TCI).

Temperament refers to the automatic emotional responses or individual differences in the strength of drives underlying basic emotions that are moderately stable over time. The "adventurous" temperament profile, with high Novelty-Seeking and low Harm-Avoidance and Reward-Dependence, consistently identified in our study populations, is known to predispose not only to adventure seeking behaviors such as would be expected in a population of extreme athletes but also to antisocial behaviors. A number of studies have also identified the adventurous personality profile in populations of antisocial and psychopathic youth and adult criminal offenders (Cloninger et al., 1994; de Pádua Serafim et al., 2014; Lennox and Dolan, 2014). Therefore, temperament alone is not adequate to determine whether an individual person does or does not have a disordered personality and a higher risk of maladaptive behaviors.

The *character* dimensions can regulate emotional impulses and conflicts in such a way that a mature and healthy personality can develop regardless of the temperament. The healthiest personalities have consistently been found to be associated with high Self-Directedness and Cooperativeness. Conversely those with low scores in these traits consistently present with immaturity associated with disordered personalities (Cloninger et al., 1993). Antisocial and criminal behaviors in populations with the adventurous personality profile have been associated with low scores in all character traits of Self-directedness, Cooperativeness, and Self-Transcendence (de Pádua Serafim et al., 2014; Lennox and Dolan, 2014).

Among the relatively healthy personalities 2 character profiles are distinguished:

1. The "organized" character structure associated with high Self-Directedness and Cooperativeness, and low Self-Transcendence. People with organized characters are very responsible, organized, purposeful, and self-confident (high Self-Directedness). In addition they are tolerant, helpful and forgiving (high Cooperativeness). However, they are low in Self-Transcendence and so they are concerned with their own interests, and of those whom they regard as friends and associates with common goals and interests. As a result the organized character is very strong-willed, practical and goal oriented, driven mainly by achieving personal goals and ambitions and less influenced by altruism, idealism and spiritual concerns (Cloninger et al., 1994; Josefsson et al., 2013).
2. The "creative" character structure has high scores on all three character traits: they are high in Self-Directedness, Cooperativeness, and Self-Transcendence. Those with creative characters have the same capacity for resourceful productivity and helpful cooperation as those with organized characters, but they are also more intuitive and altruistic, and they strongly identify with nature, humanity, and with the universe as a spiritual whole. As such they are better able to tolerate uncertainty and ambiguity and are less egocentric in their outlook. Self-realization for individuals with the creative profile is determined by virtuous behaviors and values in the service to others and in seeking harmony with nature and the universe (Cloninger et al., 1994; Cloninger, 2013; Josefsson et al., 2013).

Taking the above into consideration we propose that the adventurous personality profile has a high activating tendency

to engagement in risk-taking sports such as mountaineering and BASE Jumping. High Novelty-Seeking biases toward these exciting and challenging activities, with low Harm-Avoidance conferring confidence, vigor and low anxiety to deal with the inherent risks. Low Reward-Dependence is likely to contribute to independence and indifference to the opinion of others who may caution against engagement in these potentially dangerous sports. The potential antisocial tendencies associated with the adventurous personality under most circumstances are well-controlled by their organized character structure, which emphasizes disciplined initiative, clear goal-setting, collaboration and concern with maintenance of social norms.

However, we consider that the intense ambition to achieve a highly sought-after goal (mountain summit or a BASE jump) in the organized personality can in some situations become so dominant that it can lead to clouding of values with imprudence in self-care and care of others. It is likely that it also contributes to reckless exploitation of the mountain environment, as it is well-recognized that mountaineering is increasingly associated with environmental degradation and pollution (Apollo, 2014, 2016).

Highlighted in the introduction are examples of high-stake situations when mountaineers may have to forego the opportunity to reach a summit in order to assist or console an injured or disabled fellow climber. These situations demand critical decision-making under time constraints and often under duress from high altitude, cold, risk of avalanche and pressure from ambitious climbing partners. In these situations the ultimate desire and motivation to succeed on the ascent may, in some instances, supersede concern for the welfare of others, and erode traditional mountaineering values and acceptable human behavior, whereas in others it may lead to extraordinary acts of service in the benefit of others and self-sacrifice.

The personality profile of mountaineers is dominated by low Self-Transcendence. Individuals who score low on Self-Transcendence tend to be proud, impatient, self-preoccupied, and self-aggrandizing so that they often struggle to accept failure (Cloninger et al., 1994). Without the moderating effect of Self-Transcendence and its guidance toward altruism, the service of others and a sense of harmony with nature, the adventurous personality characteristic of mountaineers may in some (high-stake) situations manifest in considerable callousness, disregard and rationalization of controversial behaviors. High Self-Transcendence may contribute to the heroic decisions to act in the service of others instead of the pursuit of a summit.

BASE Jumping and its progression into wing-suit flying demands a very high level of performance. Wing suits act like wing parachutes and allow glide ratios that enable jumpers to glide away from cliffs and along canyons and ridgelines before deploying their BASE parachute (Mei-Dan et al., 2012). Given the speed of descent after take-off, achieving aerodynamic stability and determining a safe flight path requires a high level of performance under considerable stress. Sustained focus and meticulous attention to detail are imperative. The bias toward self-forgetfulness (i.e., absent-minded absorption) in search of transpersonal experiences that accompany Self-Transcendence is likely to be disadvantageous as this may lead to distractibility and diminished focus in jumpers. Therefore, low Self-Transcendence may be a key contributing factor to maintaining sustained focus and optimal decision-making in this population. However, the general tendency toward pride and seeking of fulfillment by succeeding in BASE jumping goals may contribute to more frequent engagement in the sport and the reported increased mortality (Mei-Dan et al., 2012).

Fortunately, both organized and creative characters can enhance their performance in extreme sports by training and practices that allow the development of both vigilance and altruism. The self-forgetfulness of the creative character involves a capacity for absorption in doing something that is valued, rather than being simply distractible. As a result, people with a creative character can learn to sustain the focus needed to look out for their safety along with the safety of others, which is a critical need in extreme sports (Rueda et al., 2011). Likewise people with organized character can develop greater altruism and joyful appreciation of nature through mindfulness of their connection with nature and other people (Campanella et al., 2014).

CONCLUSION

Despite the substantial heterogeneity in their individual personality profiles mountaineers and BASE jumpers are adventurous in temperament and highly self-controlled and organized in character. The character configurations in these populations, mostly associated with low Self-Transcendence, may in some, critical situations manifest in considerable callousness, disregard and rationalization of controversial behaviors. More investigation is needed regarding training in mindfulness and attentional control as a standard component of preparation for extreme sports. Such training holds promise for enhancing the quality and value of the experience in a sustainable way that reduces risks.

ETHICS STATEMENT

IRB approval from the University of North Carolina at Chapel Hill (IRB# 14-1942; approved 9/4/2014). This study was carried out in accordance with the recommendations of name of guidelines, name of committee with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the name of committee.

AUTHOR CONTRIBUTIONS

ME and CRC have been involved in the design of the studies, collection of data, interpretation of results and preparation of the manuscript.

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Conflict of Interest Statement: EM has previously worked as a mountain and jungle guide.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The Thrill of Speedy Descents: A Pilot Study on Differences in Facially Expressed Online Emotions and Retrospective Measures of Emotions During a Downhill Mountain-Bike Descent

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When extreme sport athletes explain the engagement behind their taxing and risky endeavors, they often refer to the happiness generated by the activities. However, during the activity, these athletes seem neither pleased nor happy. This article proposes some answers from a study of facially expressed emotions measured moment by moment during downhill mountain biking. Self-reported emotions were also assessed immediately after the trip was over. The participants display less happiness during the activity than before and after the activity. No significant associations between facially expressed and self-reported emotions were observed. Findings are discussed with reference to the functional well-being approach arguing that some momentary feelings are non-evaluative in the sense of being caused by the difficulty of the ongoing activity. Within this framework, easy tasks produce happy feelings while difficult tasks produce interest—regardless of whether a goal has been reached or not. By contrast, retrospective emotions involve the evaluation of the activity in relation to its goal. When a goal is accomplished, the accompanying feeling is positive. If a goal (or value) is threatened, lost, or not achieved, negative feelings follow.

Keywords: emotion, facial expression, online emotions, functional wellbeing approach, extreme sport, downhill mountain biking

INTRODUCTION

When BASE jumper Ryan Saunders landed successfully after a particularly challenging jump, he celebrated the achievement with a verbal eruption that lasted over 60 s: "Yes! Yes! F…ing yes! I don't care if I sound like the biggest retard in the world – that was f…ing awesome!" (NRK, 2011). Observing the scene leaves no room for doubt about Ryan's emotional state—he was as happy as a human being can be. Indeed, studies show that the feeling of happiness is among the key motivators of extreme sport (Brymer, 2005; Willig, 2008; Brown and Fraser, 2009; Hetland and Vittersø, 2012). See Kerr and Houge Mackenzie (2012) or Woodman et al. (2010) for an extended list of motives.

A bit of reflection, however, should bring forward the question of why such taxing and dangerous endeavors make people happy. Flow theory (e.g., Csikszentmihalyi, 1999) argues that these positive feelings only appear after the activity has ended (Moneta and Csikszentmihalyi, 1996). By contrast, the functional wellbeing approach (FWA; Vittersø, 2013, 2016, 2018) argues that positive feelings are actually present during flow, but that they are not experienced as pleasure or happiness but rather emotions like interest, immersion, and engagement. Following this theory, the feeling of happiness comes later, as the result of an appraisal of goal accomplishment.

In a previous study, we have used small, head-mounted video cameras to capture backcountry skiers facially displayed emotions, while they were skiing (Hetland et al., 2018 – this issue). The results showed that the participants displayed significantly less happiness while skiing than when they stopped to take a break. These results offer some support to the assumption that happiness is not generated on a moment-by-moment basis but arises after the activity has ended. Further, following the functional well-being approach, the feelings that people actually experience during such concentrated moments of challenging activities are perhaps better described as interest and engagement. Here, we refer to "interest" as an emotion, typically described as "a feeling of wanting to investigate" (Izard and Ackerman, 2000), or "engaged curiosity" (Panksepp, 1998, p. 149). Functionally, it is assumed that interest is experienced in order to foster the development of competence and skills (e.g. Tomkins, 1962; Fredrickson, 1998; Silvia, 2006; Thoman et al., 2011; Smith et al., 2014; Renninger and Hidi, 2015).

Interest is not included as one of Ekman's basic emotions (Ekman, 1993), which is the basis for the previously used facial analysis software and thus not natively included. Therefore, we were previously unable to test if the participants did, in fact, experience interest during the activity. To compensate for this limitation, we implemented here a measure of facially displayed interest, based on the work of Campos et al. (2012), who proposed a method to measure facially expressed interest based on a new combination of action units that describes facial movements.

Our previous study of backcountry skiers applied an entirely new way of capturing emotions during an extreme sport activity. We apply the same method to a new population, this time on a sample of downhill mountain bikers. In the present article, we seek to (1) replicate our main finding that happiness arises after the activity is over and (2) try to capture displayed interest to possibly test the assumption that difficult activities are characterized of momentary interest and retrospective happiness. We test this new measure on a sample of downhill mountain bikers while they bike.

Extreme Sport

Extreme sport is not easy to define, and the term is often used interchangeably with other terms such as action sport, adventure sport, and lifestyle sport (Puchan, 2004; Brymer and Schweitzer, 2013). The number of people participating in different extreme sports is growing all over the western world (Thorpe and Wheaton, 2013). According to Willig (2008), extreme sport can be defined as recreational physical activities that carry a risk of serious physical injury or even death. This definition includes activities such as BASE jumping, skydiving, hang gliding and paragliding, mountain climbing, surfing, white water kayaking, backcountry skiing, and mountain biking.

As one of many extreme sports, downhill mountain biking has increased significantly in popularity the past two decades. The sport is based on descending steep, rough terrain at high speed using heavy, specialist bikes with long-travel suspension. A downhill mountain biker needs to master technical skills to handle obstacles such as elevated, narrow wooden board ways, log rides, ladder bridges, and different drops and jumps. Falling of the bike in high speed may cause severe injury to the participants (Becker and Moroder, 2017).

Such voluntary exposure to extreme hazards has received increased scientific attention, and the list of potential motives is increasing (Celsi et al., 1993; Willig, 2008; Brymer and Gray, 2009; Woodman et al., 2010; Hetland and Vittersø, 2012; Kerr and Houge Mackenzie, 2012; Barlow et al., 2013; Arijs et al., 2017; Frühauf et al., 2017; Holmbom et al., 2017; Hetland et al., 2018). Among the important motives is the experience of positive emotions often explained in the context of flow (Delle Faveaaa et al., 2003).

Positive Emotions

A flow state is most likely to occur when the individual is intrinsically motivated to perform a given task (Csikszentmihalyi, 1975). Such motivational states are sometimes referred to as autotelic, meaning that the activity has no external goal beyond performing the activity in itself. Several criteria are considered important for a flow state to occur. Three of these are of special importance: (1) clear goals to the activity, (2) constant feedback on your performance, and (3) a balance between the challenge and the experienced skills.

However, some researchers argue that a balance between challenge and skills may not be the ideal conditions for a flow state to occur. Løvoll and Vittersø (2014), for example, argue that a small imbalance between challenges and skills creates a more optimal situation for flow. An imbalance, they argue, will lead the actor to experience emotions like interest and not pleasure and also lead the participants to be more focused and to perform their best in the given situation – which in turn may create better conditions for skill development.

Several scholars therefore point out the usefulness of separating feelings of pleasure from feelings of interest (Hidi and Renninger, 2006; Vittersø et al., 2010; Renninger and Hidi, 2011; Vittersø, 2016). Pleasure, the argument goes, works as a reward when reaching small or big goals, while interest facilitates learning, growth, and the struggle toward reaching difficult goals. In the functional wellbeing approach (FWA; Vittersø, 2016), these systems are supposed to fulfill two important needs: the need for stability (pleasure) and the need for change (interest).

The rich literature on homeostatic regulation has established as a fact that feelings of pleasure and satisfaction are internal messages about a homeostatic stability that has been reestablished. Examples of such reestablished stabilities are needs being fulfilled

or goal being accomplished (Denton, 2005; Damasio, 2018). Given the high correlations often observed between pleasure and happiness (Russell, 1980; Vittersø, 2016), it seems reasonable to assume that the emotion of happiness fulfills a function somewhat similar to that of pleasure and satisfaction. For example, a study by Shaver et al. (1987) showed that the most common cause of a happy emotion reported by their participants was the accomplishment of a desired outcome. Similarly, studies since Darwin (1872) have recognized how happiness broadcasts to us a signal about one's environment, and social circumstances in particular, being benign and favorable. Mentally then, happiness is an emotion about wellbeing. The message from a happy mind is that the current state of being is a good one; no urgent changes are required (Oatley, 1992; Wierzbicka, 1999; Ortony et al., 2005; Keltner, 2009).

By contrast, feelings such as interest and engagement keep the organism alerted and ready for effortful action. These feelings motivate activities to continue over time and during hardship, thus enabling the organism to postpone the return to homeostatic equilibrium. For example, Thagard (2002) carefully noted what kind of emotions James Watson reported in his book on the discovery of the DNA (Watson, 1999), when Watson and Crick struggled to understand the structure of the molecule. Thagard observed that feelings such as interest, curiosity, and wonder were common during phases of investigation and the generation of new research questions. Feelings such as pleasure, happiness, and beauty, on the other hand, were typically reported in phases of discovery and when important hypotheses were justified.

This view also has support in the field of neuroscience. A study by Burgdorf and Panksepp (2006) showed that endogenous opioids are involved in the regulation of the hedonic emotions such as pleasure, satisfaction, and happiness, whereas dopamine is important for eudaimonic emotions such as interest, engagement, and enthusiasm. The FWA also draws a distinction between momentary emotional experiences and the overall evaluation of an event (Vittersø, 2016). Momentary emotions are created by the execution of small acts toward a goal. Overall emotions, however, arise as a response to goal accomplishment for the activity as a whole. If a goal has been fully or partly achieved, the subject will be rewarded with a pleasant feeling of satisfaction, happiness, or mastery. However, if the goal is not achieved, the evaluation of the experience will result in displeasure and negative feelings.

Measuring Emotions

There are several ways in which emotions can be understood, and thus, how they can be measured. Several researchers separate between two different levels of emotional experience (see, for example, Nilsen and Kaszniak, 2007; Vittersø, 2013, 2018). The first level concerns the emotions experienced from moment to moment, which might sometimes be non-evaluative. The second level is retrospective, and these emotions always include a cognitive evaluation. In the current article, these emotions will be referred to as online and retrospective emotions.

The momentary and retrospective levels of emotional experience may often correlate, but they are also likely to differ. The retrospective emotions might often be biased by situational or social aspect of the situation, which have been shown to alter the actual online perspective itself (Schooler et al., 2003). In addition, high arousal, inherent in extreme sport has been reported to impair immediate emotional reports (Corson and Verrier, 2007). Time, on the other hand, has also been shown to affect retrospective emotional report (Robinson and Clore, 2002; Clore and Robinson, 2012).

Given these challenges, are there ways to measure emotions online without them being affected of the process of measuring? Kahneman and Riis (2005) have suggested that use of electroencephalography (EEG), heart rate (HR), and skin conductance might give good measures of emotional experience. Other studies have also used fMRI scanners to prove that different regions of the brain are associated with different emotional reactions. Although providing a good measure of online emotional experience, these methods are in most cases limited to a laboratory setting.

Another way of measuring online emotions is through capturing and analyzing facial expressions. In a similar study to the one described in this article, Hetland et al. (2018) filmed and analyzed the facial expressed emotions of a sample of backcountry skiers while they descended a mountain on skis. The participants' facially expressed emotions were analyzed using automatic facial coding (AFC) software. This method provided a moment-by-moment measure of emotions, which did not need a cognitive interaction with any kind of apparatus.

Facially Expressed Emotions

According to Ekman (1993), there are at least six basic emotions (happiness, fear, anger, surprise, disgust, and sadness), and these are expressed with distinctly different facial expressions. These expressions are (1) innate (Tracy and Matsumoto, 2008), (2) universal, (3) reliable measures of the subjective experience of the individual, and (4) correlate to the physiological and expressive components related to the given emotion (Matsumoto et al., 2008).

In order to get reliable measures of facial expressions, Ekman and Friesen (1978) developed the facial action coding system (FACS), a system that is based on measuring activity and movement in different facial muscles. FACS is based on 46 different action units (AUs), each of which is responsible for a particular facial movement. As an example, upward movement of the lip corners would characterize a smile and the movement is being controlled by the muscle zygomaticus major (Ekman and Friesen, 1978). In FACS, this would be described as activation in AU6 (cheek raiser) and AU12 (lip corner puller).

In a study by Campos et al. (2012), the authors provide a description of seven different positive facially expressed emotions, including facial expressed interest. A closer look shows that the facial expression in which Campos and his colleagues interpret as representing interest shares distinct qualities with the facial expression of sadness (Ekman, 1993). In Hetland et al. (2018) study, sadness was the second most prominent online emotion after happiness. However, the participant's self-reported emotions showed low levels of sadness. In a previous study on BASE jumpers and skydivers (Hetland and Vittersø, 2012),

none of the participants reported any sadness but high levels of interest throughout the jump.

The similarities between displayed sadness and interest are striking. Both interest and sadness are characterized by activation in AU1 (inner brow raise) and AU4 (brow lowered). The only difference is found in mouth gestures, where interest is described by activation of AU24 (lip pressured), where sadness is expressed by activation of AU15 (lip corn puller).

Automatic Facial Coding

In the past, facial expressions were usually coded manually by trained raters. However, as technology has improved, this can now be done automatically. Automatic facial coding (AFC) has several advantages and a few disadvantages, compared to manual coding. First and foremost, automatic capturing, interpreting, and coding demand very little labor. In addition, different studies have shown that such digital analyses outperform non-expert coders and are approximately as accurate as expert coders (Bartlett et al., 1999; Terzis et al., 2010; Lewinski et al., 2014).

In a reliability study, Lewinski et al. (2014) found that FaceReader, the software used in the present study, recognized 88% of the targeted emotions in both the Warsaw Set of Emotional Facial Expression (WSEFEP; Olszanowski et al., 2014) and the Amsterdam Dynamic Facial Expression Set (ADFES; van der Schalk et al., 2011). The corresponding number for human raters was 85%.

On the downside, the methods for coding facial expression are still developing, particularly in how they distinguish different positive emotions. It takes time before enough pre-coded material is available for a potential update of the computer model used by AFC programs. In addition, humans are able to code other movements, body postures, partly occluded faces, and images with varying image quality or perspectives in which the software is not currently able to read.

Still, the advantages of automatic coding in most cases outweigh the cost, making this method increasingly popular. It has previously been used in a number of fields such as emotion science (Bartlett et al., 1999; Chentsova-Dutton and Tsai, 2010), educational research, human-computer interaction (Cohen et al., 2003), consumer behavior (Danner et al., 2014), user experience (Goldberg, 2014), clinical investigations of facial nerve grading in medicine (Dulguerov et al., 1999), monitoring pain (Lucey et al., 2012), reaction to advertisement and commercial films (Teixeira et al., 2012; Hetland et al., 2016), and emotions in extreme sport (Hetland et al., 2018).

Aims of the Study

The overarching aims of the study are to (1) replicate the findings from Hetland et al. (2018) that happiness arises first after the activity is over, (2) test if the newly developed measure of online interest can provide us with a measure of online interest, and finally (3) to explore the relation between measures of online emotions during the activity and self-report emotions given immediately after the activity is over. Based on these aims, three hypotheses were put forward.

Hypothesis 1. Given the challenging nature of downhill mountain biking, and the rewarding role played by hedonic feelings when goals and sub-goals have been achieved, we refer to the FWA and predict that participants will experience more happiness immediately after they stop than when they are actively biking.

Hypothesis 2. On the same terms, the FWA predicts that participants will experience more interest during the activity than before and after.

Hypothesis 3. The FWA does not predict a strong relationship between the online emotions during a difficult event, and the self-reported emotions given when the activity is over.

MATERIALS AND METHODS

Participants

Twenty-four participants (two females) were recruited through social media and snowball sampling. Age ranged from 19 to 46 (M = 27.13, SD = 6.81). The sample mostly not only consisted of Norwegian citizens (n = 21) but also included bikers from Sweden (n = 2) and Poland (n = 1). All participants gave written and informed consent before participating in the study.

Procedure and Materials

The data for this study came from five different sources: two questionnaires assessing (1) background variables (questionnaire A) and (2) state emotions right after the activity (questionnaire B). These questionnaires were available in Norwegian and English and were translated and back translated to ensure equivalence across languages. Online emotions were measured with (3) automatic facial coding software. In addition, (4) heart-rate (HR) data and (5) speed were recorded during the activity. For this present study, only data from questionnaire B and the facially expressed emotions will be investigated.

Participants met up with the first author at various known DH locations, either by chance or after agreement. After signing the informed consent, participants were requested to fill out questionnaire A. When this was completed, all participants were given a special helmet, equipped with a front-mounted camera filming the face of the participant. They were also equipped with a heart-rate (HR) monitor that also recorded speed based on GPS coordinates. After synchronizing the HR monitor and the camera, participants were asked to perform a normal downhill run. Immediately after finishing their run, participants were given questionnaire B, which concluded the study. All questionnaires were answered on an Apple iPad, using the Qualtrics application.

Facially Expressed Emotions

See **Figure 2**.

The Camera and Helmet Mount

The participants were equipped with a GoPro 4 camera set to full HD (1,080) progressive, field of view (FOV) set to medium and a frame rate of 25 images per second. Based on these settings,

the film consists of 25 self-contained still images per second where the entire face of the participants was visible (see **Figure 1**).

The camera was mounted on the helmet with an extension rod connected to a standard helmet mount placed on the top of the helmet. The extension rod was also attached and supported sideways by an adapted helmet brim and fastened with rubber bands (see **Figure 2**). This setup has two advantages. First, it prevents the camera from hitting the participants' face in case of a fall. Mounted as shown on the illustration, the camera can easily detach from the front support allowing it to swing up, or sideways but not downward. Second, the two points of attachment also make the camera mount very stable. In addition, we also had five different helmets in different sizes with additional padding if needed, to make sure that the helmet fit snugly to the participants' head. This made sure that the camera would follow the head movement and thus effectively eliminating the potential problem of camera shake – which could else have been a potential problem for the analysis.

FIGURE 1 | The view given by the face-fronting camera during a DH-descent. (The participant gave his consent to use this picture).

The Technique

The videos from the camera capturing facial expressions were then analyzed using FaceReader version 6.0 (Noldus, 2015). This computer software bases its interpretations on the facial action coding system (FACS; Ekman and Friesen, 1978) when scoring facial expressions. To be able to automatically read facial expressions, the software creates and fits a three-dimensional model of the human face to the image. This model consists of a mesh with 491 different measure points that use an algorithmic approach to code movements based on the active appearance method (Cootes and Taylor, 2004). The model has been trained on approximately 10,000 images scored by FACS certified experts. The video was manually coded into different segments of (1) before the run, (2) during, and (3) after the run. The data were then exported into an excel file, before being analyzed further.

The Variables

The automatic facial coding (AFC) software detects the face, applies, and adapts the mesh to individual features, and by measuring the ongoing muscle movement between the points automatically classifies the six basic emotional expressions of happiness, sadness, disgust, surprise, fear, and anger. In addition to the basic emotions, a neutral state is also recorded. All emotional scores are ranged from 0 (not present) to 1 (fully activated). The measured emotions are not mutually exclusive, meaning that more than one emotional expression

FIGURE 2 | The helmet with camera setup.

can be present at the same time. The film was analyzed frame by frame, providing 175 measures every second, when taken all of the six emotions and the neutral state into account.

Operationalizing a Measure of Facially Expressed Interest

A new feature in the FaceReader version 6.0 gave us the opportunity to export action units (AUs) in addition to the six facial expressed emotions as described previously. In FaceReader, these data are scored from A (slightly active) to E (fully activated). Non-active action units are scored as NaN. Based on the arguments given by Campos et al. (2012), we used AU1 (inner brow raiser) and AU4 (brow lowered) as a representation of facially expressed interest. To register as interest, the two action units had to be active simultaneously. The measure was given numeric scores from 0 (not active) to 1 (both AU scored at E, fully activated) in the following way: both AU activations as originally detected by FaceReader (A–E) where transformed to ranks (not activated = 0, …, E = 5), multiplied with each other and scaled to the [0,1] interval by division by the maximum possible score of 25. The item was scored 25 times each second, providing us with the same amount of measures as the original data.

Self-Reported Emotions

Self-reported emotions were measured immediately after the activity. The participants reported five basic emotions. These five emotions were (1) happiness, (2) interest, (3) fear, (4) anger, and (5) sadness. To increase reliability of the scale, the two positive emotions, happiness, and interest were measured with three items each. For happiness, these were happiness, pleasure, and satisfaction. For interest, these adjectives were interest, engagement, and enthusiasm. The negative emotions were less important for our research goal and therefore measured with their single items: fear, anger, and sadness. The items were presented with the introduction "Now, let us look at your total experience of biking down the mountain. There are a number of emotions you may have experienced, to a varying extent. Try to recall how you felt while you were biking and check the number that best describes your emotions. Note that you have to answer the first nine items to be able to proceed." For each of the items, the participants responded using an end-point labeled rating scale ranging from 1 (not at all) to 7 (very much).

RESULTS

Duration of the Events

The measures of facially expressed emotions were divided into three different events of variable duration: before, during, and after the downhill ride. The mean recording duration before the downhill ride was M = 16.6 s (SD = 14.8 s), the mean duration for the downhill episode was M = 142 s (SD = 168 s), and the post-ride episode had a mean duration of M = 8.4 s (SD = 11.2).

Facial Expressed Emotions Before, During, and After the Event

In order to investigate whether there were differences in facially expressed emotions before, during, and after the activity, the mean automatically grade emotion scores were entered in a 8 (emotion: angry, disgusted, happy, interest, neutral, sad, scared, surprised) × 3 (event: before, during, after) ANOVA treating both factors as repeated measures. Summary statistics for this analysis are presented in **Figure 3**. This analysis revealed a significant main effect of emotion, $F(3.94, 90.53) = 19.19$, $p < 0.001$, $\eta_p^2 = 0.45$, while the main effect of event did not become significant, $F(1.61, 37.07) = 1.28$, $p = 0.285$, $\eta_p^2 = 0.05$. The emotion × event interaction, however, also showed a significant result, $F(5.29, 121.61) = 3.87$, $p = 0.002$, $\eta_p^2 = 0.14$. The Greenhouse-Geisser corrected analyses are reported because a test of sphericity showed that this assumption was violated.

The significant interaction shows that there were differences in how strongly emotions changed during movement as compared to before or after the activity between the emotions. We therefore followed up the analysis using *post hoc* tests. Our research question was focused on comparing online emotions (during the activity) to those expressed before or after the activity, and we therefore limited the analyses to comparing mean emotions before and during activity and during and after activity (i.e., we did not compare emotions before and after the activity directly). We set up the *post hoc* procedure in the following way: We calculated separate, one-way ANOVAs for each of the emotions and setup ANOVA contrasts such that before and after the downhill event were compared against facially expressed emotions during the activity. We report both unadjusted and Bonferroni-adjusted p (across the set of eight analyses). We report the unadjusted p in an exploratory spirit but urge the reader to treat these results cautiously.

The first hypothesis predicts that participants will express less happiness during the activity. There was some evidence in favor of this hypothesis as scores of happiness were reduced during downhill movement, $t(46) = -2.09$, $p_{\text{unadjusted}} = 0.041$, $p_{\text{bonf}} = 0.33$, even though this effect did not survive Bonferroni adjustment. Further, we found that facial display of anger was increased during downhill movement, $t(46) = 2.87$, $p_{\text{unadjusted}} = 0.0061$, $p_{\text{bonf}} = 0.049$, and this effect was significant also after adjusting for multiple comparisons. Finally, facial display of disgust may have been reduced during riding, $t(46) = -1.96$, $p_{\text{unadjusted}} = 0.056$, $p_{\text{bonf}} = 0.45$, even though this conclusion is only weakly supported by an unadjusted p that is marginally above threshold.

There were no further effects for any of the other facially expressed emotions when comparing before/after against during the activity (all $p_{\text{unadjusted}} > 0.12$). For a further description of the results, see **Figure 3** and **Table 1**.

Facially Expressed Interest

The second hypothesis predicted higher levels of expressed interest during the activity than before and after. As seen in **Table 1**, and as reported in the previous paragraph, there were no significant differences in facially expressed interest between the events. To conduct a more in-depth analysis of the interest variable and

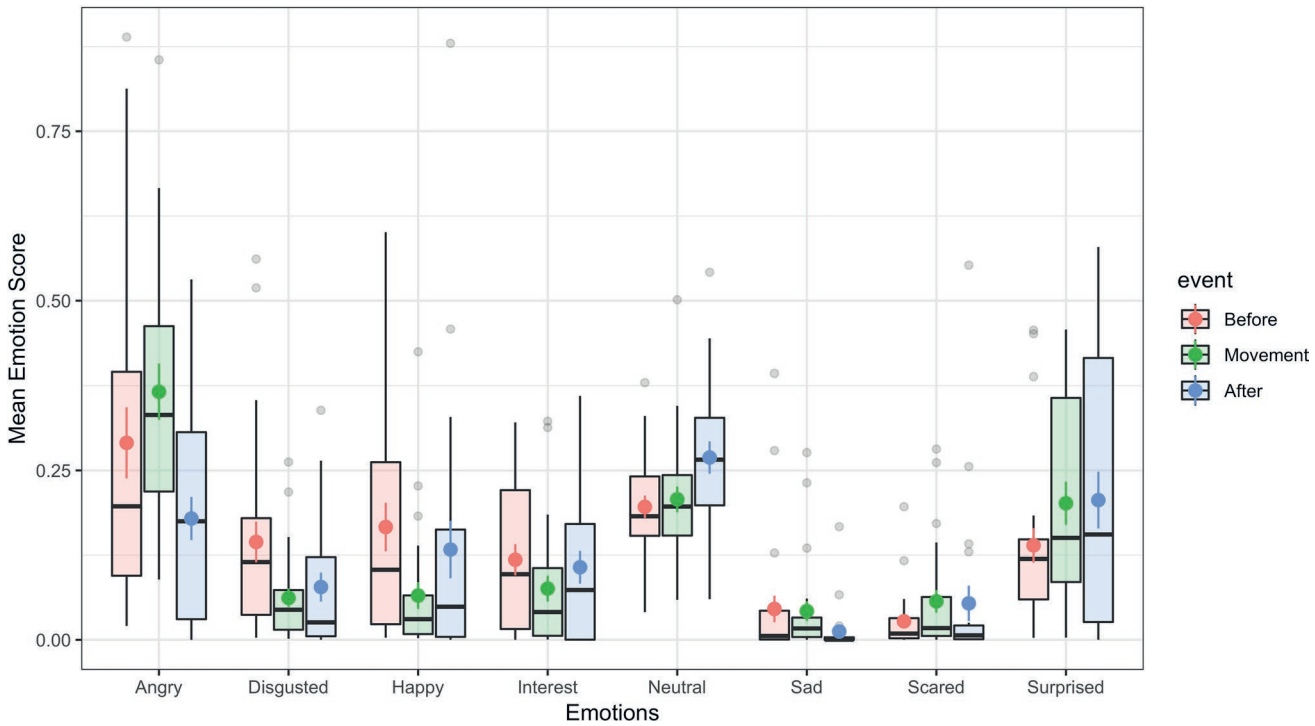

FIGURE 3 | Boxplots of individual mean scores of emotions before, during (referred to as "movement"), and after the downhill ride. Box edges represent the first and third quartiles, and the solid middle line is the median. Flankers are 1.5 times the inter-quartile range from the nearest quartile. In addition, the mean and standard error of the mean (SEM) are plotted as solid dots with error bars.

TABLE 1 | Summary of a hierarchical linear regression model with interest as the dependent variable and all other facially expressed emotions and part during the activity as predictors.

Emotions	*b*	β	SE	*t*
Neutral	–0.06	–0.04	0.16	–0.4
Happy	–0.05	–0.03	0.14	–0.37
Sad	–0.06	–0.03	0.17	–0.33
Angry	0.37	0.25	0.18	2.06*
Surprised	0.58	0.44	0.11	5.51***
Scared	0.29	0.12	0.17	1.68
Disgusted	0.23	0.18	0.09	2.51*
part	–0.05	–0.13	0.03	–1.69
(Intercept)	0.26	–	0.14	1.89

*Degrees of freedom (DF) = 159; *p < 0.05; ***p < 0.001; b, raw regression coefficient; β = standardized regression coefficient; SE, standard error.*

its development throughout the downhill experience, we divided the stream of facially expressed emotion scores during the downhill activity into seven subparts per participant (segments classified as before and after the activity did not enter into this analysis). This approach was chosen because subjects differed in the total length of their rides. **Figure 4** summarizes the development of the expressed emotions during the downhill ride. There is no clear pattern of the interest variable over the course of the ride. Some of the other emotions show interesting patterns. Happiness, for example, seems to be highest at the beginning and the end of the ride, possibly reflecting anticipatory and reflective effects. Also, both fear and surprise seem to increase during the run.

To investigate our interest variable more closely, we next conducted a hierarchical linear regression treating interest as the outcome and the other facially expressed emotions (as well as part during the downhill ride) as predictors. We added random intercepts for each subject and treated the predictors as fixed effects. This model revealed a positive relationship between interest and surprise, $b = 0.58$, $t(159) = 5.51$, $p < 0.001$; interest and anger, $b = 0.37$, $t(159) = 2.05$, $p = 0.041$; and interest and disgust, $b = 2.23$, $t(159) = 2.5$, $p = 0.013$. There was no relationship between the emotional expression of interest and the emotional expression of sadness as we predicted *a priori* based on the overlap in the involved AUs.

Facial Movement Versus Self-Report

Our third hypothesis predicted that there would not be any strong associations between the online measure (facially expressed emotions) and the retrospective measure (self-reported state emotions). First, based on the BEST-questionnaire administered after the activity, we calculated mean scores for self-reported happiness (mean of self-reports on "happiness," "satisfaction," and "pleasure") as well as interest (mean of self-reports on "interest," "engagement," and "enthusiasm"). We then normalized the self-reports to fall into the interval [0,1] to be comparable to the facially expressed emotion scores and entered them together with the main facially expressed emotions during the activity into a 2 (measure: FaceReader vs. BEST) × 5 (emotion: happy, angry, interest, sad, scared) ANOVA, treating both factors

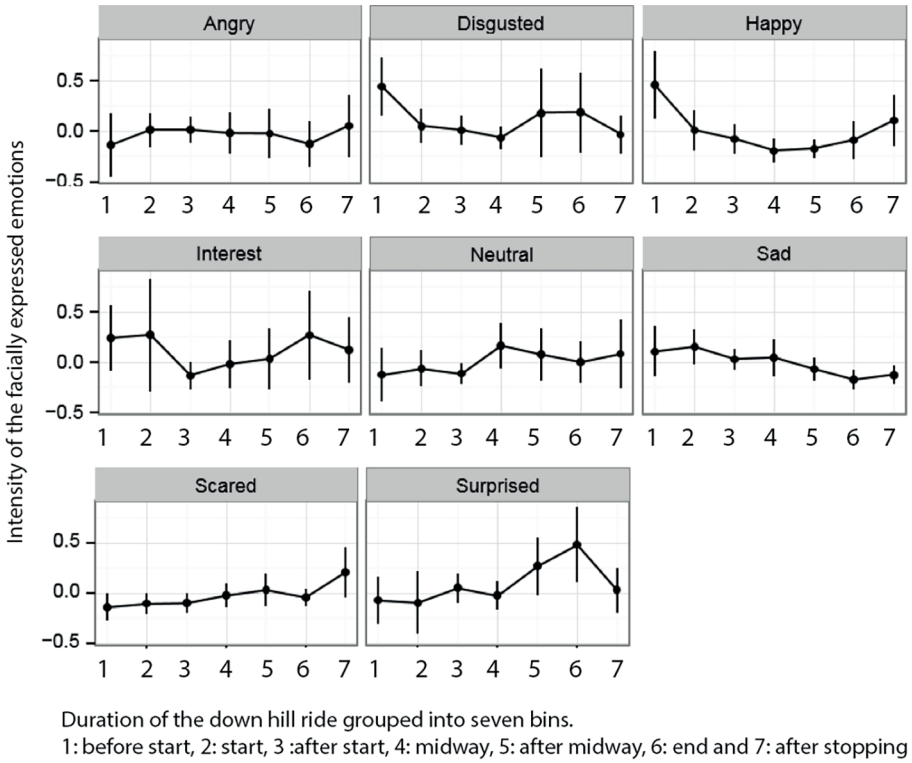

FIGURE 4 | The downhill event was divided into seven subsequent episodes, and the line in each frame shows the intensity of its respective emotion throughout the event. The dots along the lines reflect the *z*-transformed mean scores for the facially expressed emotions during each of the seven episodes, and error bars are 95% confidence intervals (unadjusted).

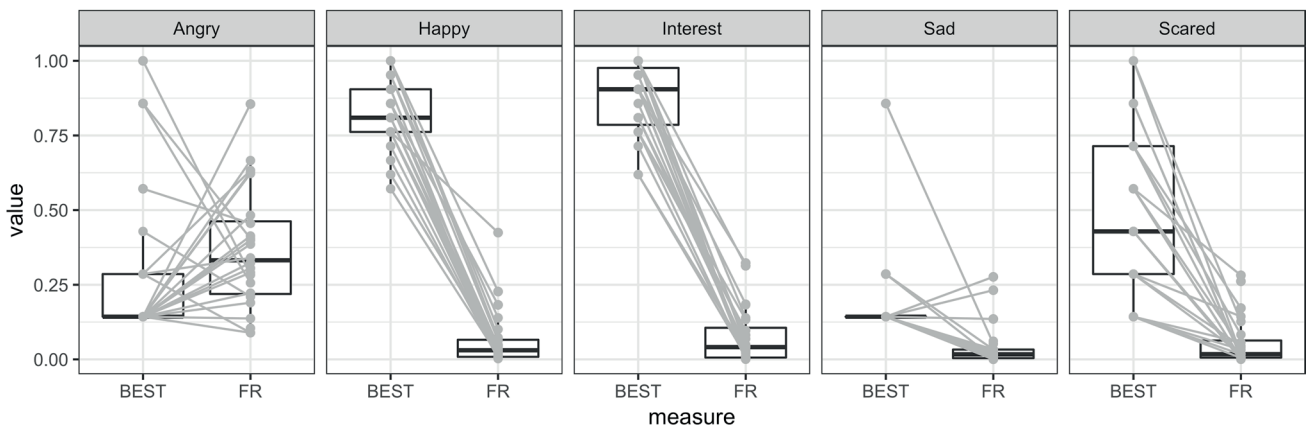

FIGURE 5 | Comparing self-reported emotions after the ride (BEST) and facially expressed emotions (FR). There are obvious differences in both interest, happiness and fear, all of which are much higher when measured using self-reports when compared to facially expressed emotions. Gray lines are individual participants to illustrate repeated measures.

as repeated measures. The results of this analysis are graphically depicted in **Figure 4**.

We observed significant effects of measure, $F(1, 23) = 292.46$, $p < 0.001$, $\eta_p^2 = 0.93$, and emotion, $F(2.76, 63.55) = 38.14$, $p < 0.001$, $\eta_p^2 = 0.62$, as well as a significant interaction between the two, $F(2.47, 56.84) = 71.99$, $p < 0.001$, $\eta_p^2 = 0.76$. The Greenhouse-Geisser corrected analyses are reported when appropriate. Given the significant interaction effect, we followed up this analysis using *post hoc* paired *t* tests between self-reported and facially expressed emotions (see **Figure 5**). Happiness was more frequently expressed in *post hoc* self-reports than facially during the activity, $t(23) = 27.1$, $p_{bonf} < 0.001$. Interest was also higher in self-reports than facial expressions, $t(23) = 28.7$, $p_{bonf} < 0.001$. Similarly, self-reported sadness was

increased relative to expressed emotions, $t(23) = 4.3$, $p_{bonf} < 0.001$ as was self-reported fear, $t(23) = 8.37$, $p_{bonf} < 0.001$. Self-reported and facially expressed anger, however, were not different, $t(23) = -1.03$, $p_{bonf} = 1.0$.

Finally, we wanted to see whether it was possible to predict emotions that were reported after the activity by including only facially expressed emotions from during the activity. We conducted a set of multiple regression analysis where each of the nine self-reported emotion variables served as dependent variables and the facially expressed emotions as independent variables. In order to encourage exploratory results, no adjustment for multiple comparisons was applied and any significant results would therefore have a highly increased chance to be a false positive. However, none of the $8 \times 9 = 72$ regression coefficients were significantly different from zero, suggesting either that facially expressed emotions are unrelated to self-reported emotions, or that the momentary emotional feelings of a strenuous event are different from the overall feelings experienced when the event has been completed.

DISCUSSION

The present article investigated the momentary emotions during, and the retrospective emotions immediately after, an intense downhill mountain-bike run. As predicted, the results showed that the participants expressed less momentary happiness while riding the bike than before the ride and also a trend showing less happiness after they had stopped. This replicated the main finding to Hetland et al. (2018), which demonstrated that backcountry skiers display more happiness when they stop skiing than while they ski. Contrary to our hypothesis, facially expressed interest was less intense during the event than the levels before and after. We also found that the facially expressed emotions during the event were unrelated with the self-reported emotions given immediately after the event. Finally, we found that the participants expressed surprisingly high levels of anger.

Our first finding shows that the participant expresses less happiness during the event than before the event, and although not significant, the trend shows less happiness also after the event. This corresponds with the explanation provided by the flow theory, which argues that while in flow, the participants are too immersed in the activity to consciously register the enjoyment created by the feeling system (Csikszentmihalyi, 1999). More precisely, the execution of a difficult task keeps the attention strictly focused on performing each step of the behavioral sequences, reducing the minds' capacity to attend to the accompanying stream of feelings. However, the feelings are still there (Damasio, 2018).

This finding is also compatible with the explanation provided by functional wellbeing approach (FWA; Vittersø, 2016). The FWA argues that people do have emotional experiences during the flow. However, these experiences are not characterized by enjoyment, but rather by feelings of interest, immersion, and engagement. Indeed, feeling interested is in itself a facilitator of a concentrated awareness. The happiness experienced in retrospect, however, does not arise as the sum of the feelings experienced during the activity, but rather as an evaluation of goal accomplishment for the activity as a whole. The first part of the FWA argument was not supported by the present results, but the data are consistent with the second part of the argument.

Within extreme sport, fear is an important emotion. It forces the participants to be alert to potential hazards, to stay focused, and to take necessary counter measures (Brymer and Schweitzer, 2013). However, Brown and Fraser (2009) argue that there is a misconception in the literature about fear as a motive for taking part in extreme sport. They argue that it is mastery and learning that is the main motivation. Willig's (2008) perspective offers support to this finding as she argues that the main motivation is both developing skills and the experience of positive emotions. The FWA (Vittersø, 2016) argues that these two motives might be connected. If the challenges posed by an activity slightly outweigh the present level of skills, this will elicit interest and communicate to the mind that some mental and/or bodily efforts are required in order to for a particular goal to be achieved. Thus, in a challenging situation like downhill mountain biking during which the participants must push themselves to the very edge of their capabilities, the FWA predicts that interest rather than happiness is the most functional feeling state. The second hypothesis in this study therefore predicted that the participants would express more interest during the downhill ride than after the activity was over. However, in contrast to what was expected, the results showed that interest also decreased during the activity.

To further inspect the emotional change during the activity, the facial expressed data were divided into seven subsequent episodes. A close inspection of these episodes revealed that happiness decreased as the activity progressed. In the last part of the trip, however, happiness started to increase, although only to a para-significant ($p = 0.07$) level. One reason why the post-event happiness was not significantly different from the event happiness might have to do with the short period of post-event measures. The facially expressed emotions were only measured for about 10 s after the downhill trip stopped. The facially expressed interest did not return a clear pattern, and the analysis also revealed extensive variation in all seven sections.

In a previous study by Hetland and Vittersø (2012) exploring emotional experiences in BASE jumping and skydiving, the participants reported a total absence of self-reported sadness. In a later article investigating emotional experiences in backcountry skiing, utilizing the same technology as in the present article, facially expressed sadness was reported to be the second most prominent emotion after happiness (Hetland et al., 2018). Facially expressed sadness has striking similarities with facially expressed interest as described by Campos et al. (2012).

This lead Hetland et al. (2018) to speculate that facially expressed sadness might partly be mislabeled interest. This assumption was not confirmed in the present study. Facially expressed interest (operationalized according to Campos et al., 2012) did not show any correlation with facially expressed sadness. In addition, facially expressed sadness was the least prominent of the facially expressed emotions. These findings cast doubt to whether facially expressed interest can be measured

with the action unit proposed by Campos and coworkers – at least in a sample of downhill bikers using the present technology.

The final hypothesis of the present study predicts that the momentary emotions during a strenuous event are governed by a different system than the emotions experienced after the event has stopped. Thus, no strong association between online emotions and retrospective emotions is to be expected. According to the FWA (Vittersø, 2018), momentary emotions are generated by a non-evaluative feedback process in which the level of difficulty inherent in the ongoing activity determines the quality of the accompanying feeling state. As for the emotions experienced after the activity has been completed, an evaluative process of comparing the result of the activity with the goals of the event determines the post-event emotion. A successful result will generate positive emotions, whereas an unsuccessful result will lead to negative emotions.

The findings from the current article show that there is no relation between the online emotions and self-reported post-event emotions. These data are thus in line with the final hypothesis. However, our results can only show that self-reports and facially expressed emotions diverge across subjects and do not prove that such relationship does not exist. It is indeed notoriously difficult to prove the null hypothesis and in order to do so, we would need to apply Bayesian statistics or frequentist equivalence testing. Unfortunately, our sample size is not large enough for such an approach. Our results must therefore be interpreted with appropriate caution.

The high levels of facially expressed anger observed in the current study were somewhat surprising. Anger was actually the most prominent of the facially expressed emotions before and during the activity. Furthermore, there was a significant reduction in anger after the activity was over. This finding was not predicted in our hypotheses. In retrospect, a possible explanation might be drawn from the association between anger and obstacles. The emotion of anger is typically elicited when an active plan is frustrated or an external source is obstructing the path toward goal achievement (Oatley, 1992). However, this explanation cannot properly account for the anger expressed before the cycling started, except, perhaps, in the form of an anticipation of possible hindrances ahead. Another reason for the result could be attributed to the fact that that facially expressed anger is characterized by lowered eyebrows and tightened eyelids, not unlike an expression of concentration. If facially expressed anger instead represents concentration, this would explain the high levels before and during, and a reduction after the activity was over. We readily admit that this explanation is somewhat speculative, and future investigations will hopefully throw more light on this surprising, but interesting, observation.

Before the cycling event, participants also displayed higher levels of disgust than they did later on. Again, this was unexpected and might be due to some kind of unconscious rejection or aversion toward the upcoming event. Rejections are, at least in general, the most common elicitor of disgust (Rozin et al., 2008). Once more, this is a suggestive interpretation, and further studies are certainly needed before conclusions can be drawn.

Limitations and Further Research

This article applied a design with automated facial coding of emotions during the high arousal activity of a downhill mountain-bike run. Even though this method opens up new possibilities, it is not without shortcomings. First, to the technical challenge of capturing facial expressions, we found that the rapid shifts in light conditions made it challenging to analyze some of the films and consequently leading to issues with missing data.

Further, in order to be able to correctly capture facially expressed emotions, the participants were instructed not to use any kind of eye protection, which again could have affected their performance during the event. In addition, the camera had to be placed in the participants' field of vision. Although most participants said they quickly habituated, these factors might have affected their display of facial expressions. As these challenges demonstrate, measuring emotions is by no means an easy task. Even though facial expression is regarded an reliable measure of momentary emotions, one needs to be cautious when translating facial movement into an emotion-laden component.

We also recorded relatively short-time segments in pre and post (a range of 15–30 s), which may cause a challenge when comparing the facially expressed emotions pre/post to during (2.5-min range).

Technically, film is nothing more than still images displayed in rapid sequence, and FaceReader also analyzes each frame as a still image. The validity of FaceReader's ability to read and correctly analyze still images is well established. Still, we would welcome a validation study with video as input to confirm this.

Finally, knowledge is still meager when it comes to analyze emotions that are not "basic" in the Ekman sense of the term. Currently, FaceReader categorizes these as "neutral," but this "grab-bag" category may have emotional content not captured by the FACS system. In spite of its shortcomings, however, this technology gives us a first peek into how an intense activity like mountain biking is experienced as it unfolds – an opportunity that has been unavailable until now.

CONCLUSION

The current article contributes to the literature in several ways. By utilizing a newly developed method for capturing facial expressions that are associated with expressed emotions by use of small video cameras and existing technology for automatic facial coding, the article provides moment-to-moment measures of expressed emotions. Further, it tests a new way of measuring facial expressed interest. However, the data cast serious doubts about whether interest can be measured according to the current description – at least in the present setting and with the current technology.

We believe more confidence can be ascribed to the results reported about happiness, and that an important contribution from the current study is the reduced level of happiness our participants expressed as they biked downhill. The happiness typically reported from these kinds of high-aroused activity

can most likely be attributed to the happy feelings observed before the biking event, and the high levels of happiness recorded after the biking had ended. So in the end, we may contribute to explaining why extreme sport athletes report happiness as one of their main motives. Not because extreme sport is an activity filled with momentary happiness, but because it creates an opportunity for development and growth – and that feels good and makes you happy.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of Norwegian Center for Research Data.

AUTHOR CONTRIBUTIONS

AH is responsible for the study and writing. EK is responsible for all data collection and substantial part of the writing. MM contributed to all statistical analyses and written the result section. JV contributed significantly to the study design, theoretical development, and writing.

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An Exploratory Study of Extreme Sport Athletes' Nature Interactions: From Well-Being to Pro-environmental Behavior

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Traditionally, perceptions about extreme sport athletes being disconnected from nature and a risk-taking population have permeated the research literature. Drawing upon theoretical perspectives from environmental, sport, organizational and positive psychology, this qualitative study attempts to explore the lived experiences of four male and four female extreme sport athletes. The purpose of this study was to gain insight and understanding into the individuals' attitudes toward the benefits of extreme sport activities for well-being, resilience and pro-environmental behavior. Eight participants (Mean age = 40.5 years; *SD* = ± 12.9) provided written informed consent to partake in semi-structured interviews. Each athlete provided written consented to allow the publication of their identifiable data and in order to facilitate sharing of their autobiographical account of their experiences. After conducting thematic analysis, meta-themes that emerged from the analyses were as follows: (a) early childhood experiences, (b) the challenge of the outdoors, (c) their emotional response to nature, (d) nature for coping, (e) restorative spaces, and (f) environmental concern. The findings convey great commonalities across the participants with regard to their mindset, their emotional well-being as well as their connectivity with nature and attitudes toward the natural environment. The cognitive-affective-social-behavioral linkage of the benefits of extreme sport participation for well-being, psychological recovery and pro-environmental behavior are highlighted. This study examining the lived experiences of extreme sportspeople provides a novel contribution to our contemporary understanding of extreme athletes' relationship to nature and its commensurate impact upon well-being and pro-environmental attitudes. The findings suggest that extreme sport participation, while inherently risky has psychological benefits ranging from evoking positive emotions, developing resilience and life coping skills to cultivating strong affinity to and connection with nature and the natural environment.

Keywords: nature connectedness, extreme sport, well-being, resilience, green exercise, blue exercise, restorative space, emotion – mood

INTRODUCTION

It has been widely assumed that extreme sports people are for the most part risk taking, sensation seeking individuals who lack connection to the natural world (Zuckerman and Neeb, 1979; Breivik, 1996; Zuckerman, 2009). However recent research shows that while this is the case for some high-risk sport participants other additional behavioral and motivational benefits may be derived from the exhilaration of the extreme sport challenge. Preliminary evidence suggests that in some extreme sports emotional experiences of nature constitute a compelling component of the overall sporting experience. For instance, interviews with extreme sport participants suggested that they cultivate feelings of connection to the natural world (Brymer and Gray, 2010). Extreme sports are considered not simply as outdoor leisure activities where the most likely outcome of mismanaged mistake is accident or death but the experience of approaching danger is integral to these sports (Brymer and Oades, 2009). This paper attempts to reconcile the commonly accepted assumption of the egocentric nature of extreme sports with the lived experiences of individuals across a range of extreme sports. It builds upon research by Willig (2008) which discusses the positive human experiences that extreme sport participation can have on an individual and also how it can enhance their relationship and connectedness with nature and the natural environment (Brymer and Gray, 2009, 2010). We are concerned with how human-nature interactions benefit an individuals' well-being and coping, in addition, to their nature connectedness.

Psychological Benefits Positive Emotions and Psychological Recovery

Research suggests that participation in extreme sport activity might develop valuable personal attributes such as courage and humility (Brymer and Oades, 2009). Other research suggests high risk sports allow participants to explore and embrace "fundamental human values" which can have formative and "transformational benefits" (Brymer and Schweitzer, 2013).

Exposure to nature has been shown to provide a range of psychological benefits with a recent review of high-quality systematic reviews showing strong evidence for improved affect as a consequence of nature contact (van den Bosch and Ode Sang, 2017). The interaction of an extreme sport athlete with natural environments might provide important experiential drives as well as help the athlete cope in moments of high stress. Anecdotal evidence from outdoor recreation enthusiasts suggests that nature can provide powerful emotional experiences, which can draw people to engage in activities such as hiking, climbing, and trekking. Some philosophical accounts have also emphasized how being in contact with nature, away from urbanization, can provide strong emotional reactions leading to a deep commitment toward nature (Gelter, 2000). Although the literature on nature experiences in extreme sports is still scarce, both the extant quantitative and qualitative literature shows how emotional attachment to the natural world as well as expected psychological benefits of being in contact with nature are central to the experience of outdoor recreation and nature-based exercise (Anderson et al., 2009; Calogiuri, 2016; Flowers et al., 2016; Hervik and Skille, 2016; Calogiuri and Elliott, 2017).

Theoretical explanations, such as Kaplan's attention-restoration theory (ART; Kaplan and Kaplan, 1989) suggests a cognitive benefit of nature contact, which has been even applied in the contests of exercise or physical activity (Hartig et al., 1991, 2003; Bodin and Hartig, 2003; Aspinall et al., 2015; Calogiuri et al., 2015; Calogiuri et al., 2018). A core assumption of ART is that *directed attention*, the act of focusing on information of no spontaneous interest by inhibiting competing stimuli (e.g., concentrating in repetitive or cognitively demanding tasks), is a limited cognitive resource that can be exhausted leading to mental fatigue. According to ART, different environments can elicit psychological restoration depending on four key qualities of the person-environment relationship: *fascination* (the extent to which the environment triggers spontaneous and effortless attention), *being away* (the extent to which the environment provide an opportunity to take distance from tasks, hassles, daily routines, etc.), *coherence* (the extent to which an environment is perceived as coherently ordered, non-chaotic), and *compatibility* (the extent to which an environment meets the inclinations of the person at the time). Natural environments are often characterized by features that are particularly efficient in eliciting psychological restoration avoiding excessive excitement, a process referred to as soft-fascination. A complimentary theory, *stress reduction theory* (SRT; Ulrich, 1984; Ulrich et al., 1991), grounded in the concept of "stress recovery" or "restoration," is based upon the premise that restoration or recovery from stress involves numerous *positive* changes in psychological states. For example, changes in emotional states including reduced levels of negative affect would be predicted to reduce stress.

Prior research has been largely grounded in the aforementioned theoretical accounts from environmental psychology which have been concerned with attention restoration and stress recovery, which are a narrow set of outcomes given the corpus of evidence on the psychological benefits of human-nature interactions (Frumkin et al., 2017; van den Bosch et al., 2017). Recently researchers have applied other perspectives including dynamical systems approaches (Immonen et al., 2018). Organizational psychology offers new insights regarding the concept of psychological recovery which are integrated with the construct of resilience and provide additional testable hypotheses. Recovery, as Sonnentag et al. (2017) posit, refers to the process of psychological unwinding recuperating or restoring physical or mental resource that counteracts the stress process triggered by job demands and other stressors. Research on recovery processes has centered mainly on psychological detachment in work-related circumstances with findings typically demonstrating a decrease in exhaustion and an increase in perceived resources. This perspective, based on psychological resources theory (Hobfoll, 1989), can illuminate our understanding of nature as a restorative place and augment the literature on therapeutic landscapes (Bell et al., 2018).

Resilience and Extreme Sport

Recent research has discussed how high-risk sports participants develop a positive and distinctive relationship with nature and

their surrounding environment which in turn can benefit the individual (Brymer et al., 2009; Brymer and Gray, 2009, 2010). The challenge of the extreme sport environment may be the process that stimulates this positive human nature interaction through the process of resilience. The lens of the resilience construct (see Bryan et al., 2017) has not been readily applied to understanding human-nature interactions. Exploring resilience as an outcome of the positive and adaptive response to the challenge of extreme sports in nature offers an opportunity to explore how stress, psychological resources, coping and psychological growth interact.

The concept of connectedness with nature or the similar concept of nature relatedness, is defined as the extent to which an individual experience being emotionally connected to the natural world (Mayer and Frantz, 2004; Nisbet et al., 2009). This concept has been proposed as having relevance not only for the extent to which a person conceive and experience his or her relation with the natural environment, but also for his or her mental health and well-being. A meta-analysis by Capaldi et al. (2014) showed that individuals who are more connected to nature tend to experience more positive affect, vitality, and life satisfaction compared to those less connected to nature. Associations have been found also for connectedness with nature with personality traits like agreeableness and openness (Nisbet et al., 2009). Moreover, individuals with more positive attitudes toward nature were also found to spend more time in natural environments (Beery, 2013; Calogiuri, 2016; Flowers et al., 2016), increasing the opportunity to engage in favorable restorative experiences, reducing and preventing stress.

The frequency with which people interact with nature as a child appear to be particularly crucial in people's development of feelings of connectedness with nature. Studies based on self-reported recall of childhood experiences of nature have found that frequent nature-interactions as a child are associated with increased emotional attachment to nature as well as more frequent nature-based activities in adult life (Asah et al., 2012; Calogiuri, 2016). There is also evidence indicating that attitudes toward as well as the subjective experience of nature-interactions can be strongly influenced by the frequency of childhood experiences in nature (Ward-Thompson et al., 2008).

Pro-environmental Behavior and Environmental Concern

The topic of environmental sustainability has been emerging as a major social issue in the present century not only in environmental sciences but also in public health. Warnings about the risks posed by environmental issues, such as air, water, and soil pollution, co-hazards of noise and air pollution, climate change and ultraviolet radiation have been raised at the highest levels including UN and EU (e.g., UN SDG's; Science for Environment Policy, 2016). In addition to our connectivity with nature, place attachment (an emotional, cognitive, and functional bond with a place) has emerged as a key psychological component fostering sustainable behavior (Restall and Conrad, 2015; Geng et al., 2015). Studies have found significant associations of both our relationship with nature (e.g., Mayer and Frantz, 2004; Nisbet et al., 2009) and place attachment (Halpenny, 2010; Scannell and Gifford, 2010) with environmental concerns and commitment to pro-environmental behaviors.

The overall aim of this study is to explore the lived experiences of extreme sports participants through semi-structured interviews. Lived experiences of extreme sport participants has been previously reported using the lens of environmental psychology (Brymer, 2010; Brymer and Schweitzer, 2015). This exploratory study will seek to add an additional layer of evidence from across a myriad of extreme sport activities including mountaineering, ski-flying, ultra-endurance open-water swimming, white-water kayaking and big wave surfing and apply the lens of positive psychology frameworks including the constructs of psychological recovery and resilience.

MATERIALS AND METHODS

Participants

Eight adults who engaged in extreme sport activities (See **Table 1**) volunteered to participate in the study (4 males and 4 females; Mean age = 40.5; *SD* = 12.9). Inclusion criteria were that all participants had to be over 18 years of age, were currently or had previously participated in extreme sport activities. The pre-selected sample were contacted by email initially and waived the right to anonymity which was part of the institutional ethical approval (EHS Ethical Approval No. 2016 _11_20 EHS).

Materials

A semi-structured interview guide was pilot-tested and developed based on a deductive approach designed to test theories of human-nature interactions (see **Table 2**).

Procedure

After providing written informed consent to participate in the study, participants were invited to interview in a place convenient to them for a face-to-face interview (N = 2) or to alternatively,

TABLE 1 | Participant name, gender, nationality and sporting experience.

Name	Gender	Nationality	Sporting experience
Easkey Britton	F	Irish	Former international professional surfer and big wave surfer
Chris Bryan*	M	Irish	International competitor in long distance open-water swimming.
Rosie Foley*	F	Irish	Channel swimmer and former Ireland rugby international (36 caps)
Sandra Hyslop	F	British	White-water kayak competitor
Jim Kennedy	M	Irish	Ultra-endurance kayak competitor
Andreas Küttel	M	Swiss	Three time Olympian in ski-jumping and ski-flying competitor
Tehillah McGuinness*	F	South African	International professional surfer and big wave surfer
Humphrey Murphy	M	Irish	Everest mountaineer and white-water kayaker

**denotes active competitor.*

TABLE 2 | Interview guide structure.

Interview section	Aim	Exemplar questions
I. Introduction	To explain the focus of the study and address any initial questions in advance of the discourse.	Do you have any questions before we commence?
II. Rapport Building	To develop trust with the participant by referring back to their prior experiences.	Please tell me about your career achievements and personal milestones.
III. Identification of Adversity	To examine coping strategies, experience of post-traumatic growth and coping with daily hassles.	What adversities have you faced in your sporting career and how have you coped and thrived in response?
IV. Green and Blue Exercise Participation	To explore frequency, type (individual/group), intensity of exercise.	What activities do you do outdoors?
V. Place Attachment	To explore place blindness, emotions associated with different natural spaces.	Do you have a favorite natural space?
VI. Access to Nature	To address barriers to engaging with nature.	Are there any other barriers or risks to being active in nature?
VII. Environmental Sustainability	To explore attitudes toward the environment and sustainability.	What are your views on sustainability and the environment?
VIII. Technological Nature	To probe if they augment authentic nature with tech. nature.	Do you need to be in nature for it to impact upon you?
IX. Additional comments	To provide an opportunity to discuss any other issues that they would like to raise.	Anything else you would like to add on how blue or green natural spaces can benefit health
X. V. Closure	To ensure any anxieties or concerns are addressed before ending the interview.	The next step will be approval of the transcript.

conduct the interview online ($N = 6$). Each athlete also provided written consent to allow the publication of their identifiable data in order to facilitate sharing of an autobiographical account of their experiences. Interviews were all conducted in English and the duration ranged from 40 to 60 min with a resulting average word count of 5,000 words (Mean = 5,390 words). Interviews were audio recorded and full transcripts were created and subsequently approved by each participant.

Analysis

The raw data quotes from the transcripts were thematically coded (see **Supplementary Materials**) based on procedures for qualitative research (Robson and McCartan, 2016). An *a priori* coding frame coupled with a theory driven approach to the development of the semi-structured interview guide facilitated an efficient coding process. The second author immersed themselves in the data by reading all transcripts a number of times. Next, they conducted an inductive hierarchical content analysis to convert raw data quotes into sub-themes under the previously identified meta-themes. Verification procedures included independent coding of the transcripts (inter-rater reliability: 85%). A third researcher provided oversight and took the role of critical friend in the coding process and re-coding process.

RESULTS AND DISCUSSION

Qualitative Analysis

The meta-themes that emerged from the analyses were as follows: meta-themes that emerged from the analyses were as follows: (a) early childhood experiences, (b) the challenge of the outdoors, (c) their emotional response to nature, (d) nature for coping, (e) restorative spaces, and (f) environmental concern.

Early Childhood Experiences

The strong influence of childhood engagement in nature has been noted previously (Ward-Thompson et al., 2008; Asah et al., 2012; Calogiuri, 2016). In our analysis of the interviews two major themes emerged under this major theme (See **Figure 1**): Positive (sub-themes: outdoor play, sport and influencers) and negative (sub-themes: running). Our former ski-flying competitor, Andreas Küttel, who had five FIS World Cup wins between 2005 and 2007, reflected on the importance of his early childhood experiences in the outdoors and how he is now trying to ensure that his son has similar opportunities:

> *My best childhood memories are just being in the forest or somewhere like the beach so of course I try to repeat that with my son also . . .going on holiday camping are some of the best childhood memories of course. Being in the forest, making fire, swimming in the lake, hiking. . .the nature in Switzerland where I grew up is fantastic.*

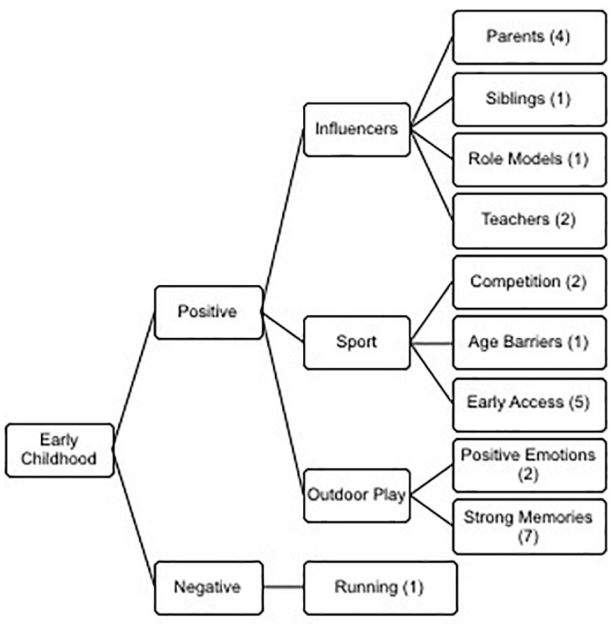

FIGURE 1 | Thematic analysis of the meta-theme early childhood displaying the four themes and nine sub-themes.

He recalls that: We could just go to a riverbank and stay the whole day there. . .we would make the dams and jump on the stones. . . kids are sort of happiest when they can just take natural things." Jim Kennedy describes the propensity for outdoor physical activity growing up by the river Lee in Cork city:

> *It was pre-TV if your heads can imagine that. There were maybe 20 to 30 kids in the streets so outside for us was just the natural thing, we didn't know any better, we would run everywhere.*

Interestingly, Sandra Hyslop, a fellow kayaker states that she hated running- "It's just really uncomfortable for me to do" conveying the multiple trajectories for individuals engaging in outdoor play and physical activity during their formative years.

Andreas described his progression from an early age directly into the sport ski-jumping: *"I have some pictures when I could hardly walk and I was already on skis. . .. That was in summer you know- summer ski jumping on plastic hills."*

He was the youngest in his club that was making trips to St. Moritz for training:

> *It was exciting as an eight to nine year old to travel with teenagers and stay overnight. You get all the skills like pack your own bag and being independent at a pretty early age.*

Sandra Hyslop, who won the Adidas Sickline extreme kayak race (e.g., Kayak race on category Class 5 white-water on river Oetz), noted both the negative and positive contribution of early childhood experience: *"We always used to go hill-walking as a family and dad was really into caving which we didn't enjoy quite so much but that was the weekend thing as a family."*

She continued "I just always like water. . .I can't remember not being able to swim." In England, she recalled that she wanted to join the swim club at 6 years of age but they refused as they didn't take people until they were 8 years old. A major life event was to provide an opportunity for Sandra:

> *We moved to America when I was seven and they are pretty big on swimming in the States [United States] so I joined the swim club there so I started and used to go like every day in the Summer. . . so it was probably pretty serious swim training from about age eight and I guess and that probably built the fitness and confidence in the water.*

Similarly, for Irish Surfer Easkey Britton, 8 years of age was recalled as a key milestone for her:

> *I'm a lifelong surfer and I've been competing since the age of eight and have surfed professionally, it's something that is a huge part of my life. From an early age surfing and the sea has been a huge part of who I am and this has continued to influence me daily.*

Fellow surfer Tehillah McGuinness sums up her early introduction concisely: "Surfing chose me, I didn't choose surfing." Big wave surfing differs from other competition events in that participants engage in tow-in-surfing and thus the waves are typically of a greater magnitude. However, she described that at 8 years old, prior to surfing, she got into long distance running: "that was like my dream to be in the Olympics." Rosie Foley describes how as a child she would try any sport with Anthony and her younger sister Orla: "Any sport that was on the TV, we were doing in the front lawn."

The participants described early access to the outdoors as a gateway into sport. Andreas specialized early for ski-jumping (e.g., progressing to Ski-Flying) and others engaged in more of a multi-sport approach but typically were in outdoor sports by approximately 8 years of age. At this age, adult support in addition to peer learning is often required.

Parental influence was instrumental for Andreas Küttel who recalled that:

> *My dad was a physical coach for the ski jumping team so I was very in touch with it and the ski jumping center is in my home town.*

This provided him with an opportunity to access the ski-jumps, observe both peers and expert performance, receive coaching, all with the support of his father. Sibling support was noted as influential for Tehillah McGuinness who noted:

> *I think I was quite a Tom-Boy – I mean growing up we were all incredibly close – my mum kind of had us in pairs – so my brother and I when we were younger, we were a year apart so I would do everything with him and his friends.*

Interestingly, Rosie Foley, who had grown up in the midst of a patriarchal rural Irish society, highlighted those influencers who had overcome social barriers to facilitate early childhood opportunities for participation regardless of gender. She recalled how a local swim teacher had introduced her to swimming in the river Shannon:

> *Peter Lacey was a gentleman renowned in this area and he used to teach people in the Pier Head how to swim with a kind of a homemade leash structure that he'd hold onto people [they were tethered] and that's how he got them going.*

In swimming, the inspirational role of coaches was also noted by Chris Bryan:

> *The coach who was at Ennis Swimming Club, Sean O Sullivan, was the father of my best friend. I regularly stayed with them at Spanish Point [coastal town 35 km from Ennis, Co.Clare]. He would have been a major influence. You could see the passion they had that really then helped me, kind of, glue to the open water swimming scene.*

Britton found her influence in a fellow female sportsperson who inspired her to take her sport to the next level:

> *Sarah Gerhardt, she is another example of someone who has inner passion for the sea and surfing with her science and she's a lecturer based in California. But she surfs outside near Santa Cruz and was one of the first women . . .to pioneer one of the big wave spots called Mavericks in the 90's . . . so this was the first time we would have seen a woman in a wetsuit in cold water, all the things that make up who I am and women who surf in Ireland but have never been exposed to, seeing that that's possible in the world and where you can go with it.*

The Challenge of the Outdoors

Extreme sport and ultra-endurance activity range in their threat to individual survival. For example, the Devizes to Westminster kayak race is renowned as a rite of passage for member of the

elite military forces and while an ultra-endurance event, the 77 portages, 125 miles of both river and canal (much of it in darkness) poses risks for athletes' welfare and physical well-being. Other examples, like round Ireland kayaking, first descents, Channel swims, extreme kayaking competitions and summiting Mount Everest on first glance would suggest that they are all extreme in nature, but our participants' voices articulate most clearly how the myriad of feats posed differential risks depending on context and circumstance (see **Figure 2**). Three major themes emerged under this meta theme in our analysis of the interviews: Risks, Effortful and Immersion.

Frühauf et al. (2017) found that challenge in the extreme sport of freeriding for some participants provided an opportunity to explore and stretch their personal limits. Extreme sports create an opportunity for participants to self-determine their own level of challenge. This theme resonated with Easkey Britton who said:

> *You're always on the edge of challenge because of the environment and definitely big wave surfing you're in extreme situations all the time so plenty of adversity in that sense. . .there is a lot of fear as well as attraction as we are drawn to water environments.*

Humphrey Murphy, one of approximately 60 Irish people who have successfully climbed Mount Everest noted:

> *Everest was a relatively straight forward one of all of them. The Everest trip in a way there was something artificial about that because of the level of structure there is around it and in terms of signature trips.*

In contrast, his expedition kayaking trips were much more challenging environments.

> *Caucasus and Siberia and they were again going out to do rivers that were very challenging but again very remote in so far as you step into gorges for a week at a time and really didn't have much of an option than to stay in them and kayak down them.*

Kayaker Sandra recounts how coupling the physical and technical challenges is the toughest aspect for her, so competition scenarios create an added pressure:

> *What's nice is the challenge. You've got to be on the athletic edge physically pushing as hard as you can and still have enough to nail the technical aspects. I did the white-water grand prix one year that's definitely the most scared I've been ever been racing.*

Stress can be ameliorated by taking on challenges in new ways as Sandra explains:

> *When I started kayaking we used to love just swimming down the rapids . . . if you'll happily swim down it then why wouldn't you kayak it- the worst that can happen is that you'll swim and so I think that's why being a strong swimmer is huge for your white-water confidence.*

While swimming in white-water has its' own challenges, open-water swimming on the other hand provides a unique environment as Channel swimmer Rosie Foley recalls: "I was reared in the water in Killaloe so I don't mind the blackness and that darkness." Rosie's extreme feat was the Channel swim (22 miles at its narrowest point) in a time of 15 h. 53 mins.

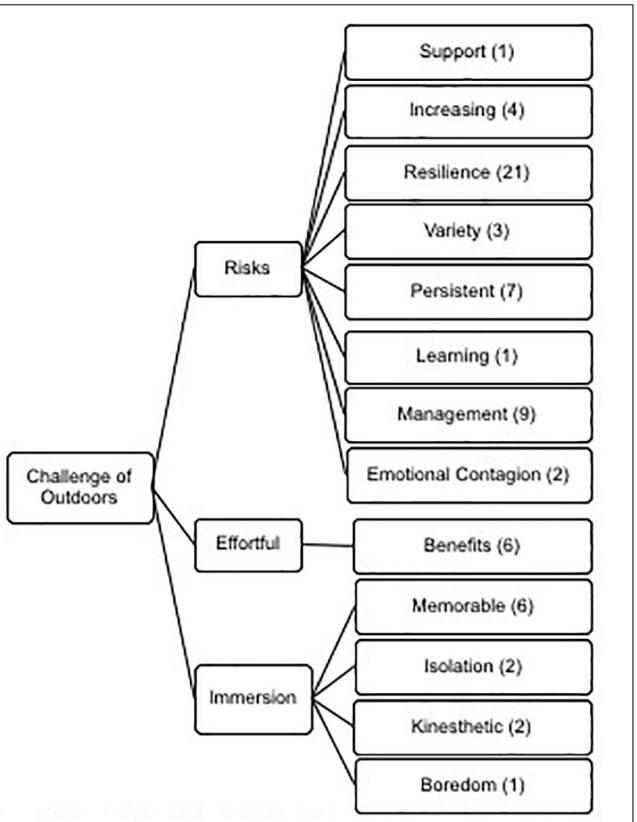

FIGURE 2 | Thematic analysis of the meta-theme challenge of outdoors displaying the three themes and sub-themes.

Their Emotional Response to Nature

Our participants emotions from interacting with nature were predominantly positive with only one potential negative outcome. The resulting themes were (See **Figure 3**) positive (sub-themes: positive emotions, calmness, variation, stress reduction, vitality, therapeutic and awe) and negative (sub-theme: disruption).

Firstly, Sandra extols the virtues of being on the water: "Pretty much whatever the river it's like once you're in the boat I'm pretty much always happy." She reflects that "just being on the water is awesome... I guess how or are you out to relax and enjoy yourself." Activity in nature as a source of positive emotions aligns with the recent scientific literature (Lumber et al., 2017).

Andreas described how nature is integral to his daily life and played a role for him when he was a competitor:

> *It's just amazing being in the nature. So yeah, it gives me absolutely a lot of energy on a daily basis but also for special occasions it gives you calmness. An important part of my competition preparations was being out in nature.*

In contrast to this calmness referred to above, Jim is inspired by the inherent vitality of nature:

> *Where the sea meets the land, is probably the most powerful place in the world. That line. That coastal line where the white waves, that's probably the most, besides volcanoes, or earthquakes,*

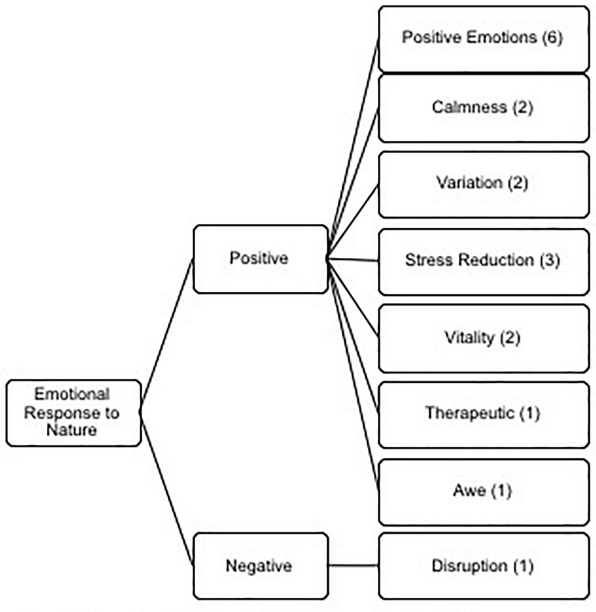

FIGURE 3 | Thematic analysis of the meta-theme emotional response to nature displaying the two themes and eight sub-themes.

that's probably the most incredibly natural forceful place in the world, a powerful place in the world. It's an amazing area.

The contrasting experiences recounted by our participants convey how nature offers a myriad of experiences with different emotional outcomes as Sandra explains:

It kind of depends on the river, which offers like different rewards I guess, you're getting the adrenaline rush if you are on the harder stuff and kind of that sense of achievement when you make it through the rapid.

For climber and kayaker Humphrey geography is no barrier:

When I am in a particular environment be it the sea or a mountain environment or an air sport environment...it evokes certain reactions within me regardless of whether that's in Ireland Kerry or the Himalayas.

He explains how we can disrupt the positive emotional response in certain situations:

Green spaces and blue spaces are unquestionably therapeutic whether we want them to be or not. However, if we do a sort of boot camp approach to the outdoors, if we are shouting at people, to do more trying, to get them to go further or faster and so on, we actually we undermine the meanings of those environments and we create a negative environment.

Nature for Coping

Nature has long been established as providing a role in coping, both in human geography (e.g., therapeutic landscapes, Bell et al., 2018) and in explanatory accounts of human-nature interactions (e.g., stress reduction theory, Ulrich et al., 1991) and within the literature on psychological recovery (Sonnentag et al., 2017). Three themes emerged, see **Figure 4**, from our analyses: Emotional regulation (sub-themes: absorption, competition) blue and green spaces (sub-theme: relaxation) and sense of loss (sub-themes: bereavement, injury). Perception of awe has unique beneficial effects for mood, according to a recent review by Lumber et al. (2017).

Our participants similarly conveyed this idea of emotional regulation through nature expressed by open-water swimmer Chris Bryan: "The beach in Sri Lanka. It has really, really strong currents. I really enjoy the rough seas as well. I swam there every day last year. It humbles me." The sense of flow, which has been evident in prior research (Brymer and Gray, 2009), appears to be linked to the multi-modal memories of those experiences as described by surfer Easkey Britton:

Obviously the emotional connection has to be there. I think it can be a very powerful especially memory. I think memory gets formed or shaped in water from experiences with being immersed in water. As a surfer you can recall exactly, a wave only lasts a few seconds but you can recall that exact moment and it could be years and years ago whereas you can't really remember so clearly what you did yesterday.

Competitive experiences provide a stimulus for a change in mindset. Chris Bryan recalled that "as I have grown it kind of had to transform, every time I had to travel internationally there was a different experience, a different venue."

Natural spaces, both blue and green, aided stress reduction and promoted a relaxation response. Two participants explain this process. Firstly, Everest climber Humphrey Murphy states that "I can physically relax in seconds, that's what I can do when I get into nature. I just let my mind go." For Rosie Foley "the emotions are just pure relaxation and just that lovely feeling of this is this is where I'm supposed to be. This relaxes me this gets everything out of me." This cleansing metaphor highlights the de-stressing effect of human-nature interactions.

One clear example of this is how Rosie, who's brother Anthony Foley (1973–2016) passed away in 2016, coped with the bereavement:

When I'm swimming I can cry, when I'm swimming I can do whatever the hell I want, when I'm swimming and it's me on my own and its fine and I'm not upsetting anyone else . . .that's how it helps me cope.

Restorative Spaces

Three major themes emerged under this topic in our analysis of the interviews (See **Figure 5**): Blue Spaces (sub-themes: imaginary, local, connectedness, reflections, favorite natural space), Blue and Green Spaces (sub-themes: beauty and connectedness) and finally, Green Spaces (sub-themes: soundscape). Blue natural spaces are different to green, with potentially greater salutogenic effects, and discrete pathways (Gascon et al., 2017).

Not surprisingly, given that more than two-thirds of our participants had extreme sport experiences in water sports, their preference for blue natural spaces were typically higher among our participants. Rugby international, and subsequently a Channel swimmer, Rosie Foley said:

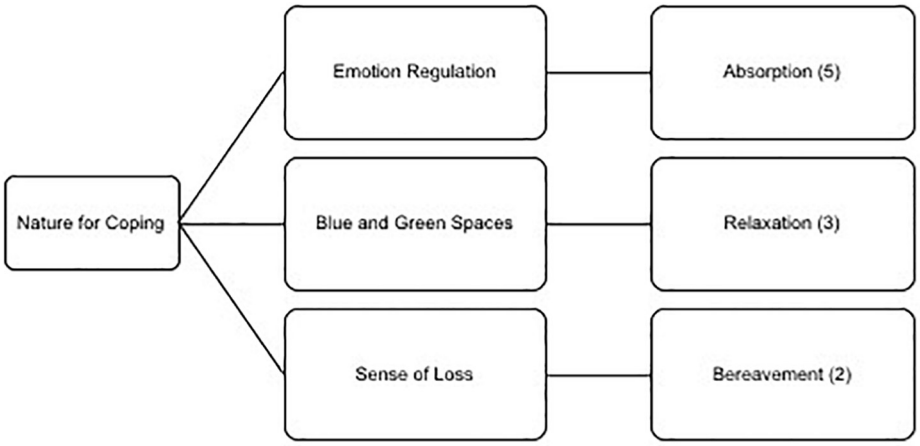

FIGURE 4 | Thematic analysis of the meta-theme nature for coping displaying the three themes and three sub-themes.

I'm more blue, I think, I'm more blue but it's funny like I'm drawn to places where there is water. . .Lough Derg to me would equate in a sense to the channel and I always felt that it was on my own backyard this is what I've spent so much time on the lake I love it here.

Rosie lives adjacent to the Lough Derg Blueway (e.g., a series of bespoke multi-recreational trails on Ireland's third largest lake over 24 miles in length totaling 50 square miles) and thus the connection to water is not unexpected. Similarly, Jim Kennedy has access to a body of water on his doorstep:

Where we kayak we have a premises there, a site, and you take four steps from it and you're in the sea, it's on the sea, on a tiny little slip about 25–30 feet high so most beautiful, spectacular place for what we do.

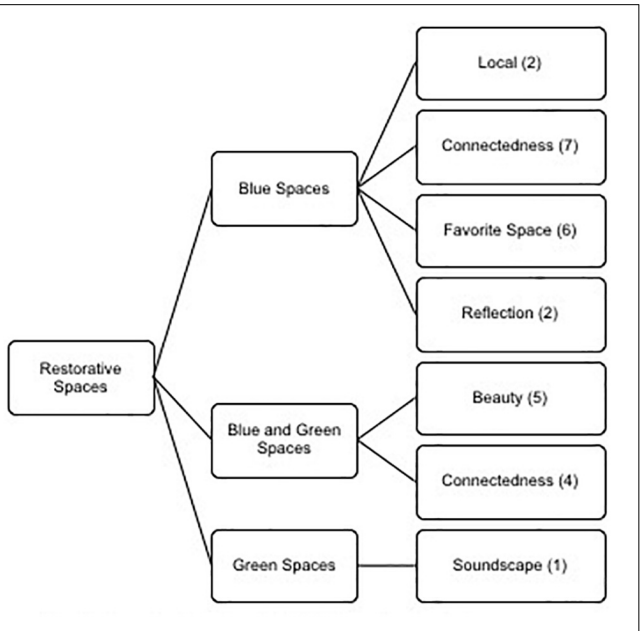

FIGURE 5 | Thematic analysis of the meta-theme restorative spaces displaying the three themes and seven sub-themes.

His traveling adventures in Mexico evoke a unique sense of connectedness across the ocean: "Mexico is our second home at this stage, so when people are on, my friends are on the water, I'm on the water here, we're actually touching each other, in a kind of a strange way. It's the same water." Sensation seeking theories (Zuckerman, 2009) fail to account for the banal beauty of the varied experiences of our performers. As Sandra states:

I think I guess some people in the white-water community find me a bit strange cause I am perfectly happy paddling on flat water for an hour and it's not as good probably as the white water but . . . I just like being on the water and I can enjoy great flatwater.

This quote highlights that it's neither the challenge nor the competition that defines the experience but the engagement and absorption with the activity in nature. This connectedness with nature is conveyed by a lucid description from Humphrey Murphy: "the outdoors is a more real place than most else in my life. This idea resonates with Andreas who explains "I often tried to find a place where I feel this is like a center of energy." Open-water swimmer Chris explains:

I used to go out to Killaloe quite a lot. . .And again it was that combination of cold water and just, eh getting away from it all, that it was actually the one time that I could stop and frame my thoughts. So that was actually really valuable to me. And sometimes I didn't appreciate the value that had, in that I didn't get out there enough to do that.

Sandra echoes these sentiments: "I love getting out in nature, if you are by yourself enjoying some space and getting away from everything." Experiences in nature appear to have a restorative function –they provide energy to the participant and instill a sense of recovery. The role of nature in promoting psychological recovery through positive emotions (Sonnentag et al., 2017) resonates through the participants descriptions and merits further investigation.

This restorative function of nature was mirrored in descriptions of their favorite places. As Easkey explained: "I travel a lot and coming home has always had the restorative aspect and back home to Donegal where I grew up and that has that kind of energy." In a similar vein Andreas describes his hometown:

> *There is a lake and we had a small place at this lake. When I was an athlete I was actually swimming there before breakfast. My wife would not call it swimming as I was just making 100 m out and in again. But I was in the water practically every morning in Summer, cycling home, having breakfast, and starting training at nine. And then after the training at four or five o'clock I went again to this place, doing stretching, and it was all so organic. . .I guess today, you would call it "exercising mindfulness."*

Jim's favorite place is idyllic but imaginary:

> *I have never actually physically seen it. But it's a tiny little beach, it's about 50 feet wide, and there's shells on the left-hand side and there's a slope on the beach, and I know it intimately.*

There is a cognitive flexibility in the approach of our participants in how they access nature and optimize their interactions as described by surfer Easkey Britton in conveying how she goes to green natural spaces for well-being:

> *If I go to say London for work within a few hours or a few days I feel like claustrophobic and I need to be near the sea –nature yes definitely beautiful forests, yes, I love the forests but the sea that's kind of what mentally does it for me."*

Aesthetics of nature resonate clearly with our participants, supporting the findings of Lumber et al. (2017). As the quote from Tehillah stated:

> *When we moved from Jeffreys Bay to the United Kingdom, as I said we moved from living right – basically I stood up in bed and opened my window and I could see the sea. . . And we moved from that to a little village where you wake up and see sheep in the field, it was green and it was as beautiful as that was it was different and for me, it kind of evokes different emotions.*

The ubiquitous influence of nature, whether blue or green, is integral to Easkey's connection with nature: "I'm also passionate about overcoming that sense of separation and disconnect I suppose we have between land and sea nature and culture and ourselves and nature." For Rosie "the green has brought us some great places around the world I have to say so if we are walking the dogs or walking with the kids or we are going cycling." Soundscape is also important in this restorative function of nature as Andreas explains:

> *I'm having a workshop with the Swiss ski-jumping team and what we actually do, sometimes out in the nature, is just lay down, breath and say what do you hear and suddenly you hear all kinds of birds and I hear all kinds of noises.*

What is termed *soundscape* (Aletta et al., 2016), which concerns the sounds perceived and understood by individuals, is integral to the multisensory experience of nature.

Environmental Concern

Marine social Scientist and surfer Easkey Britton, currently employed on the Horizon 2020 SOPHIE project, showed her research insights in her comment: "I think the real barrier or issue is even when we do access its' the quality of the environment... I think we are at crisis point when it comes to the health of our oceans." Three themes emerged under the major theme of environmental concern (See **Figure 6**): Sustainability (sub-themes: travel, energy, culture, pro-environmental behavior, education and responsibility), Pollution (sub-themes: oceans and plastics) and Ecosystem Services (sub-themes: recreation).

Our participants were well-placed to have an opinion on the challenge of the sustainability of their outdoor activities. None more so than Jim Kennedy, who as an adventure tourism provider described how he could see the beauty of it:

> *We are actually passionate, most people like us come into the business for the passion, of nature of our business, so that's what's happened, and we're like-minded people who are pushing adventure tourism at a very high level, very professional level, but one of the benefits of that, we're educating people, and sustainability, how to look after the sea, learn how to respect the waters, the walkways, the rivers, the trees, everything.*

Sandra too was aware of the apparent contradictions in desiring to protect the wilderness and access it, sometimes by helicopter.

> *I'm definitely love being outdoors but I would definitely be hypocritical to say how much I care about it, I like to buy a lot of*

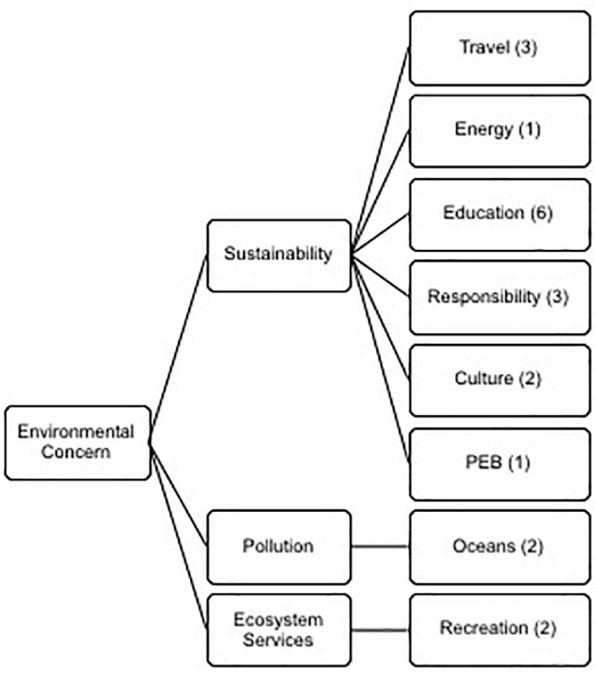

FIGURE 6 | Thematic analysis of the meta-theme environmental concern displaying the three themes and eight sub-themes.

plane tickets I drive to a lot of rivers . . . it's not something I feel 100% awesome about.

For Andreas in his post-athletic career role he reflects on sustainable travel:

It's always a question when you travel so much. When I have teaching at University, it is one and a half hours away from where I live. It's a lot of commuting and you always ask yourself if this is avoidable or not. . . I try to use the bike when I can.

He elaborates and states: "I think we are quite biased because here (e.g., Denmark) everything is about green energy and that's the focus here and it's not like this everywhere in the world." He describes a range of pro-environmental behaviors (e.g., no plastic bag when shopping) and says how "with travel you see different cultures who have different attitudes toward garbage." Cultural differences in attitudes toward sustainability have been shown in recent surveys. For example, in the European Commission (2017) only 56% of the Irish sample (N = 1,002) agreed that citizens themselves were not doing enough to protect the environment, compared to the higher level of awareness among respondents from Denmark (59%) and the EU (EU28: 66%). Not surprisingly, pro-environmental behavior including smart travel (e.g., public transport, walking, bike) are more commonly reported activities to reduce harmful emissions into the air in Denmark (41%) than Ireland (33%; EU28: 35%). Irish people rated air pollution as a lower priority issue (47%-lowest among EU 27) with similar discrepancies for items relating to the depletion of natural resources (EU-27 36%, IE 28%) and the loss of natural ecosystems (EU-27 26%; IE 19%). Among sport participants their values and attitudes may also be different depending upon their sport. Sandra gives the example of energy:

Kayakers are always super anti-hydro . . .cause dams ruin rivers but then the part of me that's like has looked into different energy forms and stuff your like really hydroelectricity is quite a good renewable energy source compared to fossil fuels.

According to Tehillah McGuinness there is an imperative for those in outdoor sport to "*really push these things and get people involved. . .maybe not so much self-promotion but more taking care of the planet.*"

This concept of personal responsibility was clearly expressed by the former Pro-Surfer: "I think if we all take it upon ourselves I think hopefully that should make a difference. . . we have a huge responsibility to kind of to protect it and to encourage people." The theme of education resonates with secondary school teacher Rosie Foley: "Why not start to educate from a very young age they want to know everything so we talked about plastic and the planet." The participants insights reflected an understanding of the reciprocal benefits of human environment interactions. One of our surfers, Tehillah, sums this up succinctly: "the ocean is kind of what pays our bills in a way. We are earning money through being able to enjoy the ocean." Our findings on environmental concern supports prior research which suggests that engaging with nature can have an impact on an individuals' environmental concern (Ferrer-i-Carbonell and Gowdy, 2007; Brymer and Gray, 2010; Brymer and Schweitzer, 2013).

Limitations

Qualitative sampling has limits with regard to generalizability and potential role of the researcher in biasing the research findings (Robson and McCartan, 2016). An uncontrolled factor in this qualitative study is the possibility that the sample participants were experiencing different stages of transition within their particular extreme sport career. A caveat is required in the interpretation of our findings which included three active participants and five who had retired from extreme sport. On the other hand, we had a broad sample drawn primarily from water sports with a gender balanced sample which is uncommon in studies of extreme sports (e.g., Frühauf et al., 2017). The findings are arguably more generalizable to the specific sports in question and this aligns with the view that high-risk sport participants should not be considered a homogenous group (Woodman et al., 2013). It is arguable that ultra-endurance sport activities in natural settings are distinct from traditional accounts of extreme sport activity and future research should address these distinctions. Similarly, ski-flying, the more extreme end of Nordic ski-jumping competition occurs an alpine setting whereas ski-jumping may be conducted in less natural settings. Regardless, the training settings are typically similar in their natural settings and attempts to categorize sport activities should include both competitive and training settings.

From a qualitative perspective (Robson and McCartan, 2016), researchers may question that interviewers work can be flawed by individual perceptions, inferring that recall biases can persist or that the researcher opinions can dictate the findings. This concern was addressed by employing a semi-structured approach to the interview which enabled flexibility in the discourse and the interview guide was largely informed by theories, thus the task was to confirm theory-based suppositions from an exploratory perspective.

Pathways for Future Research

This exploratory study sows the seeds for future research which could employ a mixed-methods paradigm, and ideally apply a longitudinal perspective. Constructs such as "resilience" clearly resonated with the experience of this sample of extreme sport participants. Longitudinal research designs would enable the exploration of the dynamic emotional responses to nature interactions that may cultivate resilience.

A review of psychological recovery from an organizational psychology perspective suggested that natural environments seems particularly useful to replenish depleted resources (Sonnentag et al., 2017). In another achievement context, research is proliferating on the concept of recovery within elite sport (Kellmann and Beckmann, 2017; Frank et al., 2018). Developing interventions to help athletes engage with nature as a means of psychological recovery would be a worthy pursuit for researchers and practitioners. Thus we have two strands of research –one to examine how those in outdoor settings benefit from the challenge as well as the recovery processes enabled by the natural settings and another stream of research to explore how natural settings can facilitate recovery for athletes in both outdoor sports and indoor sports or those that occur in a hybrid

or built environments (e.g., field games, or canoe slalom on artificial channels). One interesting question is whether athletes in outdoor sports, particularly those in extreme sport scenarios, gain more from recovery in natural settings than those with perhaps lower levels of nature connectedness (e.g., competitors in indoor racquet sports). These questions are worth of further qualitative exploration and quantitative analysis.

Recent research has focused on how Olympic athletes may benefit from greening of their competitive and training environments to enhance well-being (Donnelly et al., 2016). With the Olympic and Paralympic Games of Tokyo 2020 on the horizon and the third pillar of Olympianism being the "environment," it may be useful to explore how athletes can become champions of a sustainable approach to ecosystem services.

The role of early childhood experiences highlighted by our interviewees provides a fitting backdrop for the development of both blue and green infrastructure to facilitate recreation and sport activity in natural spaces. The concept of Blueways, which are water and land-based routes with supporting infrastructure, may provide an opportunity for early access to sport activities and recreation in nature. Contemporary evidence supports both the health and mental health benefits of access to green space (Dadvand et al., 2014; Engemann et al., 2019). For example, a longitudinal study of 1 m Danish children reported a 55% lower risk of developing a mental disorder (after adjusting for other factors) if you grow up proximal to green spaces (Engemann et al., 2019).

Human-nature interactions cannot be simply reduced to concepts such as *exposure* (Frumkin et al., 2017), as nature has distinctive personal (e.g., nature relatedness; Mayer and Frantz, 2004; Nisbet et al., 2009), cultural and societal meaning. Meaning involves having aims and being absorbed by something that stimulates awe, curiosity, pleasure and other positively evaluated experiences (Howell et al., 2013). The increasing urbanization, environmental degradation in urbans settings and the digital immersion suggest that the meaning of nature should be preserved to benefit human and environmental health (Townsend et al., 2018). This role of meaning, place attachment and life orientation are worthy of concern for future research to ensure nature's place is not displaced in our lives.

CONCLUSION

Our sample displayed commonalities in their mindset, their connectivity with nature and attitudes toward the environment. Their differences paled in significance relative to their overlapping values, goals and responses to interacting with nature in the context of extreme sports. Interestingly, kayaker Sandra Hyslop said during her interview that "my dream, when I was about five or six, was to swim the Channel (e.g., English Channel)-still haven't done it yet. . .one day!" From the English Channel to the top of Everest the nature of the challenge can change but the natural world still arouses a complex rich and consistent response among extreme sport performers.

ETHICS STATEMENT

The project Title: 2016_11_20_ EHS GO Green Ex-Green Exercise in the Community: A Case Study Approach received ethical approval on Jan, 9th 2018 from the Education and Health Sciences Faculty REC at UL. Participants had the option to waive their right to anonymity so that the case -studies could include their identifiable personal narratives and scores from Principal Investigator: Tadhg MacIntyre. Other Investigators: Aoife Donnelly, Giles Warrington, Andree Walkin, Greig Oliver Collaborators Dr. Giovanna Caloguiri (INN Norway) & Prof. Marc Jones (Manchester Metropolitan University). This research study has ethical approval until December 2018.

AUTHOR CONTRIBUTIONS

TM, AW, and GO conducted the interviews and developed the *a priori* coding system. AW conducted the initial analysis with an independent analysis performed by TM. GC was the critical friend for the qualitative analyses. In addition to the aforementioned, SG, AD, JB, and GW were part of the research design, ethics application and contributed to both the original manuscripts and the revisions.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2019.01233/full#supplementary-material

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