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Critical mountaineering decisions: technology, expertise and subjective risk in adventurous leisure

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ABSTRACT

Humans have developed strategies of varying complexity to augment their probability of survival and success in complex environments. In contemporary outdoor adventure scenarios, advances in knowledge, training and technology have been adopted to make us safer, or make us *feel* safer. Avalanche-prone terrain is one such complex environment where uncertainty is key. A small-sample pilot study was conducted during a 3-year trial of mandatory avalanche transceiver, shovel and probe use at Glenmore Lodge, sportsotland National Outdoor Training Centre. The perceived effects that the equipment might have on participants' risk perceptions and risk-taking behaviour were investigated through semi-structured interviews. Patterns of avalanche risk perception and relationship with the safety equipment varied strongly between expertise levels, and a discrepancy between declared risk behaviour and action, demonstrations of optimistic bias and defensive denial were evident. Wider implications are suggested regarding subjective relationships with both risk and technology in adventure settings and, in our leisure more generally.

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Introduction

Certain forms of leisure activity have emerged at the edge of the risk-commodity spectrum, with uncertainty and danger as a primary draw, whether governed by skilful practice or indiscriminate chance. Adventurous leisure in the outdoors exemplifies this curious social construct, built as it is on activities in which participants engage directly with the potential for physical and mental harm (Boniface, 2000; Ewert & Hollenhurst, 1997; Heywood, 2006; Kerr & MacKenzie, 2012). In the case of winter mountaineering leadership and practice, many of these phenomena converge as the experience of familiar landscapes becomes dynamic in changing weather and snow conditions, mediated by relationships and individual personalities. In this specialist sector of the leisure industry, a range of training programmes and technologies have emerged to enhance safety in the field. However, in this complex environment, such interventions have led to paradoxical outcomes, where risk behaviour may in fact increase (McCammon, 2004). This study aimed to explore ways in which this paradoxical relationship can occur, and how policymakers, influencers and practitioners can encourage high-quality decision-making in critical situations of uncertainty, by examining the narrative accounts of professional and non-professional participants of contrasting expertise levels. In this sense, this paper contributes to a well-established and long-running conversation in this journal and others, concerning our relationship with expertise and risk in

outdoor leisure (see specifically Bentley & Page, 2008; Buckley, 2012; Creyer et al., 2003; Kane & Zink, 2004; Lynch et al., 2007).

The context of the study is Winter Mountaineering in Scotland, an activity with many inherent hazards related to steep terrain, hostile weather and highly varied snowpack stability. A key danger in this arena is the risk of avalanche, which is caused by areas of snowpack weakness in layers hidden beneath the surface.

Sharp and Whalley (2010) report that between 1980 and 2009 a total of 158 reported avalanche incidents in Scotland accounted for 2% of all reported Scottish mountaineering incidents. Of these, 59 avalanche fatalities were recorded, accounting for a disproportionately higher rate of 6.9% of all fatalities in mountain incidents, indicating that avalanches have a higher mortality rate than other forms of mountain incident, despite still being a small proportion of incidents overall in Scotland. Evidence from US-based accident data shows that use of a transceiver can reduce burial time and mortality (Brugger et al., 2007); however, there are no data to suggest that similar results would occur in the UK mountain climate.

Avalanches and the 'TSP'

The transceiver, shovel and probe, or *TSP*, was a central area of subject matter during this study because a fatal avalanche accident during the previous winter had precipitated a 3-year trial period by sportscotland to issue transceivers to each participant and instructor as mandatory safety equipment on winter courses at Glenmore Lodge. The transceiver works by permanently transmitting an electromagnetic signal at 457 kHz while switched on, which can then be detected and tracked by any other similar device in 'search' mode. The detected signal can give the searcher information about both direction and distance of a buried casualty. The probe (for finding people) and shovel (for digging them out of the snow) are required to complete the rescue of a buried victim.

The effectiveness of avalanche transceivers as a companion rescue device depends on the ability to locate and recover a buried avalanche victim in enough time to avoid death by asphyxiation (Boyd et al., 2009; Haegeli et al., 2011). Haegeli et al. (2011, p. 793) make an important comparison between snow-types, indicating that burials in maritime snow-types (as found in the Scottish climate) have dramatically reduced estimated survival times compared to continental snow climates (from approximately 18 minutes to 10 minutes). This is thought to be related to the increased snow density reducing oxygen supply and applying greater compressive force on the chest (Haegeli et al., 2011, p. 792).

It is also well known, however, that in avalanches either of a larger scale, or which involve deep burial in a terrain trap or trauma injuries from complex terrain features (normally rocks and scree in Scotland, but also falls over cliffs, or trees in Alpine regions) survival is doubtful regardless of search time or devices used (Boyd et al., 2009).

Risk, judgement and expertise

Achieving goals under the uncertain conditions of a winter mountain environment demands skilful action and learned strategies in order to make good decisions and avoid harm. Concepts surrounding risk of loss or harm occurring have preoccupied mankind in many different forms and cultural representations throughout history, often linked to deep socio-cultural, technological and religious transformations over time (Lupton, 2013). In the mountain environment, where decision-making is focused on realising opportunities as well as avoiding harm, the terms 'danger' and 'risk' become synonymous in the risk discourse (*i.e.* 'the conditions were too risky'), and the probability of a successful outcome (risk of gain, as opposed to loss) is not normally considered. The more typical attitude among mountaineers in common with other extreme sport athletes (Brymer, 2010) tends to prefer the hypothesis that the successful outcome (gain) is the basic expectation, and risk of loss or

injury is the undesirable result of failure. It may, therefore, be simplest to focus on the undesirable outcomes linked to hazards and dangers, defining risk as the *probability* of loss or harm occurring, and the *severity* of that loss. While this risk construct focuses on harm, it is also a source of stimulation, where the right balance of skill, competence and risk are known to provide the intrinsic reward of important positive feelings, such as flow and peak experiences (Boniface, 2000; Csikszentmihalyi & Csikszentmihalyi, 1990; Ewert, 1994; Kerr & MacKenzie, 2012; Lyng, 1990). Indeed, judgement and decision-making are fundamental skills demanded of the mountaineer, and the hallmark of expertise (Kahneman & Klein, 2009). Cater (2006) explores risk perception and attitudes among Adventure Tourism *participants* and Adventure Tourism *providers*, finding clear practitioner-client differences in risk perceptions and motivations. He contrasts the commodification of 'fear and thrill' with ontological *risk*, and the paradoxical notion that the participants in so-called 'high-risk' adventure activities require a great deal of trust in the safety of the professional provider.

Links with sensation seeking personality factors (Slanger & Rudestam, 1997; Zuckerman, 1971) contrast with findings that other motivators including self-efficacy, mastery, self-expression and accomplishment may be more important (e.g., Llewellyn & Sanchez, 2008; Ewert, 1994, p. 18). This is echoed by Gilbertson and Ewert (2015), who found a nuanced relationship between risk, sensation seeking and other social motivations to participate in adventure activities.

These commentaries regarding the perceived level of risk point to the problem that, as Rosa (2003) highlights and explores, the epistemological and ontological arguments around 'risk' are constructed by our perceived understanding and recognition of the world:

In this view risk only exists when we recognize it. Risk, therefore, cannot be distinguished from risk perception. . . .

. . . Thus, in this formulation, risk is entirely a subjective phenomenon. There are no objective conditions in the world where the word risk applies. It is only when conditions in the world are dangerous and are perceived to be so that risk has meaning. (Ibid.: 67)

Much of the work discussed up to this point, including the definition of risk offered previously, assume 'risk' to be an objective and ontological fact, and indeed, under conditions where accidents occur, they can happen regardless whether the actor perceives the conditions as dangerous. However, Rosa's statement and other discussions, such as Ebert and Robertson (2013), reveal that there is a need to examine the role of individual perception and action in developing a deeper understanding of the embodied engagement in mountain landscapes and our subsequent decisions, with the materialities and affordances which generate both opportunities and threats. Llewellyn and Sanchez (2008, p. 422) found that climbers will engage in risk 'if they believe themselves capable of managing the risks effectively', indicating high self-efficacy (Bandura, 1977), as also seen by Brymer (2010) and Holland-Smith and Olivier (2013) in extreme sport athletes' narrative of their engagement in risk. Lyng's (1990) concept of 'Edgework' pre-dates these studies, as a wider social identity construct of extreme risk taking behaviour built upon a motivation to negotiate the "'edge," or boundary line' between order and disorder (Ibid.: 857). Again, Lyng's research showed that protagonists constructed this identity on a belief in agency and control over this extremely unstable (and often uncontrollable) state, possibly an extreme example of high efficacy expectations, rather than reckless sensation seeking.

Llewellyn and Sanchez (2008, p. 421) postulation that experienced climbers take *calculated risks*, for example, is a belief that is widely held among climbers and mountaineers to be self-evident, as might be the view of *edgeworkers* seeking more extreme situations. This belief warrants closer examination, as it is important to establish what underlies the 'calculation' that the actor is using.

Theories of *Heuristics and Biases* (HB) (Tversky & Kahneman, 1974), provide a valuable set of perspectives in the understanding of the nature of risk perception. They are underpinned by the dichotomy and tension between conscious, rationalised *deliberation* and non-conscious *intuition*, finding a wide range of situations where cues presented under conditions of uncertainty or high

cognitive demand can lead to systematic errors of judgement. A ‘heuristic’ is variously considered to be a mental shortcut or ‘rule of thumb’, which may be a useful method to avoid lengthy and effortful deliberations, but it is linked to intuitive thinking, which can be prone to unconscious biases and failure to apprehend key elements in the environment. As such, HB research is dominated by the pre-supposition that humans are fallible decision makers, a notion that drives a range of related concepts in this field of study. Tversky and Kahneman (1974) original work proposed three key heuristic ‘types’: ‘Representativeness’, ‘Availability’ and ‘Adjustment from an Anchor’. Other related or similar concepts have been introduced since, some linked to Tversky and Kahneman’s work (e.g., Affect Heuristic, (Finucane et al., 2000); Heuristic Traps (McCammon, 2002)), and some arising independently from separate reasoning (e.g., Risk Homoeostasis (Wilde, 1998)). Weinstein (1980), for example, found that a combination of defensive denial and cognitive error led subjects to an Optimistic Bias, where they *believe* that they are more likely than the average to experience positive events and less likely to experience negative events, testing hypotheses drawn from Tversky and Kahneman (1974) representativeness heuristic.

Wilde’s (1998) theory of Risk Homoeostasis is drawn from an unrelated field of population-level safety behaviour patterns in response to seatbelt regulations, proposing that people respond to safety measures by increasing their risk-taking behaviour, in a feedback mechanism hypothesised to retain a *homoeostatic* or ‘ideal amount of risk’. This notion has driven widespread debate in the mountaineering community, as can be seen through the respondents in this study. The trial issuing of TSP to all groups at Glenmore Lodge was both a useful context within which the study took place, and an important topic of enquiry in the interviews. There is no current research available into the potential effects of this equipment on avalanche risk behaviour, but studies into cycle and ski helmet use have found mixed results, with only limited support for the phenomenon (e.g., Esmaeilikia et al., 2019; Phillips et al., 2011; Scott et al., 2007).

Applied HB research in avalanche terrain is predominantly focussed on skier decision-making, and a good deal of the research has been based on backcountry skiers in the USA and Canada, where the culture and the climate produce a very specific set of challenges (e.g., Furman et al., 2010; Haegeli et al., 2012, 2010; McCammon, 2002).

McCammon (2002, 2004) made what is arguably the most widely influential development in applying heuristics and biases in avalanche decision-making, by presenting six separate ‘heuristic traps’ that relate back to Tversky and Kahneman’s original concepts, and which can lead to potentially catastrophic decision errors by participants to venture onto avalanche-prone terrain, even in the face of apparently clear contraindication in the available information.

Kahneman and Klein (2009) identify the ‘validity’ of the learning environment as a crucial factor in the learning and development of accurate intuitive judgements and expertise in uncertain environments, in which there is a need for ‘... stable relationships between objectively identifiable cues and subsequent events ... and the outcomes of possible actions’ (*Ibid.*: 524). They argue that an *uncertain* environment disrupts this relationship between cues and outcomes, reducing both its validity and the learning that can be gained from the experience. This argument presents an important problem for intuitive judgement of avalanche risk, since any person who does not encounter an avalanche on a snowslope under potentially avalanche-prone conditions will receive immediate feedback that the slope is ‘safe’, which may be incorrect. The way they can process this feedback will be dependent on a complex array of experiences, knowledge and information from the environment, which means the possibility of constructing a false perception of safety is arguably high (Stewart-Patterson, 2016). This is especially notable as a function of expertise levels, as identified by Hallandvik et al. (2017), who find different strategies being used between skier expertise levels to gather information about the snowpack, avalanche hazard and terrain. They also noted greater sensitivity to avalanche information in the environment among the more expert-level users. Landrø et al. (2020, p. 10) conclude that ‘Avalanche expertise is not defined by knowing existing decision-making frameworks, but rather by effectively using a range of decisive factors at

the right stage', alluding to the more subtle skill-set of situational awareness as fundamental to decision-making.

Work in the area of *Naturalistic Decision Making* (NDM) by Zsombok and Klein (2009) and others focuses on intuitive processes in expert decision-making, suggesting that intuitive forms of situation awareness and pattern recognition contribute to the more adaptive, accurate and resilient decision-making capabilities of expert performers. This resonates with the problem of environmental validity and learning expressed by Kahneman and Klein (2009) previously, suggesting that high-level expertise might offset errors attributed to Heuristics and Biases. However, McCammon (2004, p. 1) himself reflects that a personal motivation to investigate Heuristic traps was the loss of his close friend 'Steve' in an avalanche, despite being a 'skilled' backcountry skier in an experienced group 'with avalanche training'. According to McCammon's account, they were caught in circumstances where cues were available for safe route choice, but apparently the rational decision process was flawed. It seems plausible therefore that even with highly accurate observation and judgement skills, cues may be missed or misinterpreted. McClung (2011) suggested, for example, that judgements may be biased in favour of a desirable hypothesis that the snowpack is stable. This would create a drive towards overconfidence (and optimistic bias) in the individual's own intuitive judgement. It is important for even experienced perceptions of avalanche risk to be met with some degree of caution, calling for a review of the influences that drive the cultural norms and behaviours of participants in this specific adventure arena.

This study seeks to better understand the interplay between declarative knowledge-based and non-conscious drivers in avalanche risk perception and decision-making, in relation to expertise and experience in the environment, and asks to what extent these declared perspectives can be considered reliable. The specific context of the present study also draws in aspects of professional leadership responsibility, and the various roles of 'leader', 'participant' and 'practitioner'.

Method

The focus of this small-scale study centred on safety practices and equipment in winter mountaineering in Scotland, and its relationship with the attitudes, behaviours and decisions of mountaineers. The aim was to gain a better understanding and insight into this, by examining evidence of conscious (declarative) and non-conscious (intuitive) aspects of decision-making in potentially highly pressurised, risky mountain settings. Semi-structured interviews were used, focusing on concurrent qualitative analysis to build a more complete picture of people's attitudes and behaviours regarding avalanche terrain and other factors, using a grounded theory approach (Charmaz, 2014).

Ethical approval was sought and obtained for this research from the University of the Highlands and Islands. It was crucial to pay heed to the socio-cultural context of the research project (Davies, 2007, p. 5), in which most participants were drawn from students and staff of Glenmore Lodge (sportscotland National Outdoor Training Centre). While this provided access to informants who were directly relevant and associated with the study context, it was also likely to bring a degree of social homogeneity among the groups. The centre as an organisation plays an important role nationally in the outdoor leisure and tourism sector as a high profile opinion-leader, reflecting sector best practice; this provides the socio-cultural context of all courses that occur, and is an important influence on the behaviours and decisions of course participants and staff.

Additionally, the first named author, who conducted the interviews, is a qualified and experienced mountaineering instructor holding the *Winter Mountaineering and Climbing Instructor* qualification (WMCI). Crandall et al. (2006, p. 36) express the importance of 'getting up to speed' with the target professional domain in qualitative research, avoiding the difficulties that may be faced by a researcher who is new to a domain, with an 'overwhelming' volume of information to process. The socio-cultural context of this interaction is an important factor, providing both benefits and drawbacks to the qualitative research process. It facilitated more

effective steering of the direction of the interviews, allowing greater responsiveness as an interviewer, as well as providing a contextual underpinning for the ongoing thematic analysis. The second author's experience of the mountaineering context stretches over 50 years of recreational playing, climbing, skiing and journeying in the mountains of England, Scotland and Norway and beyond. This provided a useful critical counterpoint to the 'professional' orientation of the first author and generated a wider interpretation of the themes.

Sampling and data collection

Eighteen semi-structured interviews were conducted, each of duration between approximately 30 and 50 minutes. The participants were course students of Glenmore Lodge at varying levels ($n = 8$, Table 1), as well as qualified Mountaineering Instructors (WMCI) and Mountain Guides (BMG) and trainees who held various professional roles ($n = 10$, Table 1). The interview process revealed within-group differences in expertise, so the learners and staff were broadly broken down further into an approximate expert-novice spectrum, using three separate groups assigned by the authors (*Novice*, $n = 7$; *Transitional*, $n = 3$; and *Expert*, $n = 8$). These groups were based on the characteristics of Dreyfus's (2004) 5 stages of skill acquisition, where the *Novice* group aligns to stages 1 and 2 (*Novice* and *Advanced beginner*), the *Transitional* group matched stages 3 and 4 (*Competence* and *Proficiency*), and the *Expert* group aligned to stage 5, of the same title. At a more pragmatic level, the expert group also aligns with the definition used by Landrø et al. (2020, p. 3): "a person that has a large share of his/her daily work in avalanche prone terrain, performing real-life decision-making on behalf of themselves and in some cases others, and has done this for many winter seasons". The *Transitional* and *Expert* groups consisted of practitioners who were either training to become, or who were practising professional mountaineering guides and instructors, holding responsibility and expertise in leadership, instruction and guiding, as well as contextual expertise in the mountain environment. The *Novice* group members, by contrast, were all present at Glenmore Lodge by definition because of their reliance on the more expert groups for leadership and knowledge transfer, implying a fundamentally different approach and understanding of the mountaineering context, which becomes evident in the discussion. Despite the potential incongruity of this relationship, all members of the *Novice* group did have prior experience of the mountain environment and an understanding of the principles of mountain safety, and they reflected a spectrum of abilities

Table 1. Glenmore Lodge, sportscotland National Outdoor Training Centre course student participant profile.

Individual code	Expertise group	Gender	Relationship to Glenmore Lodge (or other)
E1	Expert	M	Self-employed Freelance Instructor at Glenmore Lodge, WMCI
E2	Expert	M	Self-employed Freelance Instructor at Glenmore Lodge. WMCI
E3	Expert	M	Mountain Training Scotland, WMCI
E4	Expert	M	Mountain Guide at an independent SME, BMG
E5	Expert	M	Mountaineering Instructor at an independent SME, WMCI
E6	Expert	M	Self-employed Freelance Instructor at Glenmore Lodge, BMG
E7	Expert	M	Full-time Instructor, Glenmore Lodge, WMCI
E8	Expert	M	Self-employed Freelance Instructor at Glenmore Lodge, WMCI
N1	Novice	M	Student, winter mountaineering
N2	Novice	M	Student, advanced winter skills
N3	Novice	M	Student, winter skills
N4	Novice	F	Student, winter mountaineering
N5	Novice	M	Student, winter skills
N6	Novice	F	Student, winter skills
N7	Novice	F	Student, Mock client for WMCI assessment candidates – introduction to winter climbing
T1	Transitional	F	Glenmore Lodge Domestic staff and former student, Winter Mountain Leader training
T2	Transitional	M	Glenmore Lodge Trainee instructor ('Night watch')
T3	Transitional	M	Glenmore Lodge Trainee instructor ('Night watch')

within the definitions used by Dreyfus (2004). Table 1 gives a summary of the interview participant profiles, showing participant gender as well as the relationships of participants with Glenmore Lodge, sportsScotland National Outdoor Training Centre. Among the *Expert* group, there were no female informants available for interview during the period of the study, which reflects the much more limited gender diversity in this area of the professional outdoor sector.

Participants were recruited on an *ad hoc* basis, by seeking volunteers from the residential student and staff population present at the Centre. Interviews were conducted over a period of 6 weeks, outside of the normal daily course activity times. Interviews were also conducted with other key informants from organisations other than Glenmore Lodge, as identified in Table 1. The number of respondents was limited by seasonality, interview opportunities and availability of interviewees, as well as being deliberately constrained by a process of ongoing analysis and data saturation (Suri, 2011). A consistent pattern emerged among the 18 interviewees, and further collection of evidence was providing little new in terms of themes and critical evidence. This sampling approach brings concomitant risks of small sample bias, although the data saturation encountered is indicative of the socio-demographic homogeneity of the centre's professional and client populations. Future recommendations would be to focus in greater depth in a single expertise group to look for further distributions of responses.

All interviews were recorded for transcription and analysis. Participants were informed verbally prior to the interview that the data would be confidential, the format would be semi-structured, and they were encouraged to give honest, discursive responses to questions.

A semi-structured format was favoured because the focus of the research demanded a relatively narrow range of questions, while maintaining the flexibility to explore specific areas of knowledge held by the broad range of informants (Bryman, 2008, p. 438). The interviews with students and staff followed similar structures, aiming to elicit personal responses from informants about perceptions and views of principles of mountain safety, avalanche risk, socio-cultural influences on mountain safety behaviours, the role of safety equipment, and views of the use of transceivers.

Discussion and findings

An ongoing thematic analysis was conducted of the transcribed interview data, in which eight separate thematic dimensions emerged consistently during the interviews. The mountain learning environment was, naturally, a common factor with all interviewees, as was expertise in mountaineering, and its relationship with avalanche risk perception, giving context to all the thematic dimensions identified. A summary of all main themes that emerged from the thematic analysis is shown in Table 2.

We have attempted here to assemble a set of arguments that emerged from the interview data. The areas of discussion below represent the themes and patterns extracted from the thematic analysis, based on the 'Thematic Dimensions' and 'Elements' taken from Table 2.

Relationships with avalanche risk

Expert-novice differences were evident in several areas, but most fundamentally it appears in the interview data that perception of avalanche risk differs most clearly as a function of the level of experience of the informant.

This could be seen in comments from N6 expressing the impact that this early experience had on her perception of the avalanche risk, which showed awareness of avalanche avoidance strategies, albeit linked to an exaggerated perception of risk compared to expert practitioners.

Some key themes emerged in the more novice informants, including an abdication of responsibility and an implicit trust in the 'guide', coupled with a sudden reversal of perception from avalanches being very unlikely to avalanches occurring 'all the time' (N6). The key factor that appears to increase the perception of risk among the more novice groups was the *salience* of

Table 2. Summary of interview data thematic analysis.

Thematic dimension		Elements	
Relationship with avalanche risk Expertise, experience and leadership Attitude and relationship towards TSP	Perceptions of avalanche risk	Own decision-making strategies	Knowledge and experience
	Relationship with trusted professionals	Responsibility and duty of care	Passivity and dependence vs proactive decision-making
	Positive, adopting for personal use <i>e.g.</i> , Personal safety Safety of others Cost and bulk <i>not</i> prohibitive Will <i>not</i> affect decision-making Heuristic traps	Sceptical, rejecting for personal use <i>e.g.</i> , Irrelevant to mountaineering Will affect decision-making Ineffective for Scottish context – burial question Cost and bulk prohibitive 'Gut feeling'	Physical presence of TSP Increased salience of risk and anxiety response will reduce risk taking Presence will increase risk taking (Risk Homeostasis argument)
Heuristics – conscious awareness	Heuristic traps		Planning and declarative decision strategies
Heuristics – evidence of unconscious bias	Heuristic traps	Narrative signals of availability heuristic – over-weighting salient cues	Risk Homeostasis
Decision-making strategies	Naturalistic decision-making and cue utilisation	Verbalisation	Risk Homeostasis
Media roles	Social amplification of Risk	Attenuation of risk	Rule-based strategies
Locus of critical reflection	Internal reflective dialogue	External third-party dialogue	Influence on participation Narrative signals of optimistic bias
			Narrative signals of defensive denial

information relating to higher than normal probability of avalanche risk, illustrative of Tversky and Kahneman (1974) Availability Heuristic. Proximity to physical evidence of avalanche activity (including issuing of transceivers) is a key influence regarded highly by all interviewees, although the information was processed in very different ways by *Novice* compared to *Expert* groups, with a very different weight and meaning attached to the information.

The *Expert* group showed the least variation in their perception of avalanche risk, universally expressing a strong reliance on their own judgement skills, with more in-depth declarative knowledge of environmental cues. This was often given in a far more objective fashion, with a confident assertion of their own approach to avalanche risk, such as E2, who expressed a reflective strategy and some important safety techniques, stating: 'I've managed to deliver my courses [...] without going into that high [risk] area'.

This indicates that the process of increased knowledge gained through experience does provide expert practitioners with a far more detailed conceptual framework around which the perception of risk is formed, *via* a combination of accumulated knowledge and integrated understanding. The *Transitional* group perceived greater risk in the environment than the *Expert* group, showing a more vivid 'imaginability' of avalanches occurring, which varies even within the group in relation to experience and knowledge levels.

Attitude and relationship towards TSP

The majority ($n = 7$) of the *Expert* group reported being against adopting transceivers for personal use in mountaineering, mostly identifying that good planning and decision-making outweigh the need for rescue equipment, and that the fundamental aim in mountaineering is to not get caught in an avalanche. This, along with confidence in their own ability to use knowledge and skill in avalanche avoidance led most to feel that the equipment was, at best, irrelevant to them; this was the most frequent response made. In the thematic dimension 'Attitude and relationship towards TSP' (Table 2), some key reasons cited by informants for holding a sceptical viewpoint of transceiver use are shown, falling into two main categories: either that the equipment is inappropriate to the Scottish context, or citing potential negative personal impacts of using the equipment, either physical (bulk, weight) or cognitive (affecting decision-making).

The latter (cognitive) area is an emergent theme of discussion in the mountaineering community and draws upon the concept of Risk Homeostasis (Wilde, 1998). The implication of this in use of transceivers would suggest that mountaineers equipped with TSP may be more likely to proceed into potentially dangerous avalanche terrain, contradictory to assertions of personal competence. There was considerable discussion and reflection in the interviews about whether a risk homeostasis effect is likely to occur, with a deeper understanding of the issue evident with increasing experience. We must emphasise that the research was not seeking to find whether or not the TSP equipment would cause

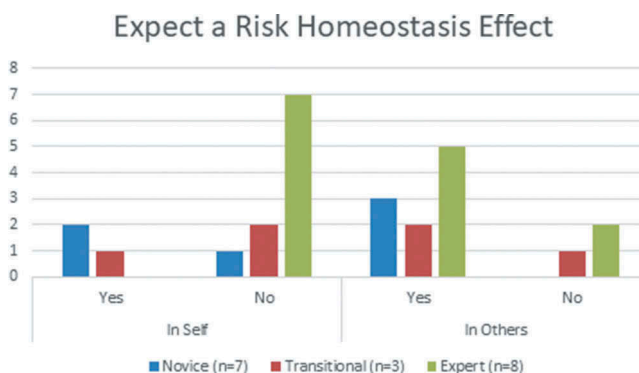


Figure 1. Graph showing respondent expectations of risk homeostasis effects.

a Risk Homoeostasis effect – rather it emerged as a key signal of the unique perspectives that people take in positioning themselves relative to their perception of risk.

In the *Novice* group, uncritical support was often given to the use of transceivers as a means of increasing personal safety. This typical sense of acceptance and trust in the equipment was more associated with informants with less mountain experience, whereas more critically aware responses and greater diversity between subjects was observed at higher levels of experience.

Analysis of the responses and language used reveals a clear dichotomy of views expressed in this area, where opinions may be categorised as: ‘expecting some undesirable Risk Homoeostasis effect to occur’, or ‘rejecting that any Homoeostasis effect will occur’ (or no data); these can be grouped depending if it is expected in self or others, summarised in [Figure 1](#). The information is drawn or inferred from the data, and the ongoing and emergent nature of the thematic analysis process meant that there is no data on this question from five of the interviewees.

An *Expert* group informant (E2) rejected the risk homoeostasis argument outright, opposing the suggestion that the TSP would encourage riskier behaviour:

I’m not stupid, and I don’t like people calling me stupid, and when people say that [effect] to me I think they’re calling me stupid. ... And I don’t think my clients are stupid ...

An alternative view raised the possibility that this effect might occur in others of (typically) less experience, as expressed by E3:

... the thing is that people always look for a crutch ... so the people I’ve got a concern about are the people that are getting transceiver, shovel and probe strapped to them and sent out into the hills thinking “well, actually I can’t remember all of that stuff, but I’ll be ok cos I’ve got this stuff on ... if anything happens it’ll all be fine”

Among all groups, those believing that Risk Homoeostasis might affect *themselves* were always in the minority, with most rejecting this possibility, such as the following dialogue with Transitional group member T1:

T1: Well I think the main drawback is that people might think ... “Oh well there’s a high risk of avalanche, but I’ve got my gear, I’ve got my stuff, people can come and dig me out”

Interviewer: Can you see it in yourself maybe that there’s a potential for a shift in your own sense of personal safety, whether you’re equipped with such equipment or not?

T1: No, I can really draw the line as using those devices as an additional help, and I would not risk myself or my group or friends ... because I have extra additional safety devices.

Evidence of optimistic bias

Patterns suggesting an Optimistic Bias effect emerge through analysis of the interview data in relation to Weinstein’s (1980) findings of five event characteristics that predict the likelihood of optimistic bias in estimation of risk: *degree of desirability*, *perceived probability*, *personal experience*, *perceived controllability*, and *stereotype salience*.

Breakwell (2007, p. 83) comments that, while an individual may be correct in estimating his or her risk to be lower than average, it is not statistically possible for the *majority* of a population to have lower than average risk. In the case of the *Transitional* and *Expert* groups, a lower than average estimation of avalanche risk may be justified by their greater knowledge and skill; however, evidence in the interview data suggests that this estimation may still be subject to other defensive denial factors. Four members of the *Expert* group reported having been directly involved in an avalanche during the past 10 years, one of which required a mountain rescue operation (the subject had been seriously injured). The informants were not asked directly whether they had been involved in an avalanche, and this had been volunteered, so the actual figure may be higher. This reminds us that expertise does not remove the risks, and paradoxically it may increase individual exposure to the hazard.

Figure 1 illustrates a polarisation of opinions between the different expertise groups on their expectations of Risk Homeostasis effects to occur in themselves and others. Here, all ability levels showed a higher expectation that the effect would occur in third party ‘others’.

When discussing Risk Homeostasis, the respondents displayed a clear pattern in their use of first- or third-person perspectives. This was echoed throughout the interviews when discussing risk, in which two clear styles of dialogue were exhibited. These can be typified as either an *internal* reflexive dialogue, or an *external* third-party dialogue. This contrast was most evident in the *Transitional* and *Expert* groups, where the stereotypical ‘avalanche victim’ type is characterised in the third person as high risk compared to the group to which the individual belongs. Similarly, high risk situations were characterised using stereotypes, in the external third-person dialogue style, creating an objective separation from such events.

Internal reflexive dialogue was either adopted to explain positive risk avoidance strategies or to critically reflect on personal situations in which incidents or near misses have occurred. In the latter cases, the event or period is described dismissively, where the causal factors are fully resolved and put down to experience, implying that those risk factors no longer exist. Dialogue from E4 reflects critically on the causal factors that led to a serious avalanche incident earlier in his career:

I was susceptible to the desires and aspirations of my clients on that day ... so I made bad decisions ... I'm there to make good decisions and if the decision is “no” then that's me doing my job, that's fine.

An important difference between the *Transitional* group and the *Novice* group emerged in the increased evidence of the informants' ability to integrate knowledge of safety strategies, coupled with a stronger sense of optimism evident in their assertions of the degree of control held over the risk. Both of the trainee instructors were similar to the *Expert* group in expressing a strong sense of confidence in their own ability to make safe decisions about avalanche risk, and both referred dismissively to formative experiences of mountaineering in relatively recent years, appearing incredulous at the former naivety that they recall.

A trainee instructor (T2) reflected on a perceived ‘near-miss’, when ‘it hasn't avalanched, but my feet have slipped slightly, and I've gone down a little ... and I certainly won't make that mistake again’. This is problematic because it is not always possible to know (with certainty) what the mistake was, and with weak feedback properties it may take a long time to learn the idiosyncrasies and variations of the environment. McCammon (2000) found that skiers who had attended basic avalanche training were *more* likely to subsequently expose themselves to greater risk of avalanche, partly due to the added (over-) confidence gained in their own decision-making. This illustrates a problem that is inherent in the development of avalanche safety knowledge, since, according to Dreyfus (2004) and Farrington-Derby and Wilson (2006) the rule, skill, knowledge and metacognitive decision-making approaches do not develop at equal rates, and more advanced beginner (*i.e.* post training) learners will be less adaptable in their application of knowledge and skills than experts (Tozer et al., 2007). This is compounded by the fact that absence of an avalanche is not equal to absence of risk, and feedback gained from not being avalanched may reinforce the behaviour and encourage a misconception of the available information.

These factors represent a strong potential for optimistic bias to emerge in mountaineers. Scrutiny of the interview data in relation to Weinstein's (1980) five cognitive and motivational factors that contribute to optimistic bias reveal the following inferences that are relevant to more expert practitioners: (i) *degree of desirability* is likely to be high (McClung, 2011); (ii) *perceived probability* is likely to be low due to an individual's high confidence in his or her own decision-making skills and route choice; (iii) *perceived controllability* is likely to be high for the same reasons; (iv) *personal experience* of avalanches is entirely subjective and unpredictable, and although vicarious experience gained from social influences and media sources may have an amplification effect, the relative rarity of actual avalanche incidents (Sharp & Whalley, 2010) may indicate that this will remain low; and (v) *stereotype salience* appears to be frequently used by informants to distance themselves from stereotypical ‘high risk’ groups and behaviours.

This may also be due to a phenomenon of recent years in the professional field of mountaineering of ‘much more . . . pressure not to make mistakes and to be more cautious’ (E7). Despite this pressure, circumstances where decisions are required to balance perceived risk with perceived success do routinely expose practitioners to potential avalanche risk, so factors that play at an unconscious level have the potential to bias and encourage a person towards the greater risks.

Conclusion

Although this study was undertaken in the context of winter mountaineering, wider implications emerge about the cognitive processes behind decisions in risky adventurous leisure situations – from mountain biking, to climbing and skydiving. A key aim of this research was to identify evidence of behaviours and responses that may be driven unconsciously in risk-based decision-making, and which are therefore *not* apparent to the informants themselves. In this, inferences need to be drawn through examination of paradoxical evidence that contrasts with the declared perspectives of respondents.

As expressed in the introduction, the uncertain nature of avalanche risk is due to localised snowpack weaknesses that exist in layers hidden beneath the surface. For the experienced mountaineer or guide, ongoing expectations of hazard are constructed through a fusion of information gathering and personal knowledge and skill. It can be argued that this estimation of risk provides the mountaineer with a perceived sense of agency and control in response to this uncertainty, creating an implicit safety frame of risk expectations.

Wegner (2007) discusses the paradox of the common experience of a *sense of causal agency* over our own actions and behaviours, pointing out instead that this ‘sense’ is a product of our *subjective* experience of a causal sequence of events that occurred at a non-conscious level. The ‘own agency’ perspective is evident in the interview data, especially in the more expert informants, who report *only* responding to relevant environmental cues, and who report a wide range of experience to draw upon. Indeed, performing ‘rationally’ brings a sense of displayed responsibility and credibility. However, the findings lead us to question the validity of this declared knowledge as a full explanation of human behaviour in less predictable mountain scenarios.

Further, the research revealed a wider notion that accumulated experience may also be internally re-shaped by defensive denial and optimistic bias, confirming and reinforcing the sense of agency. The broader conclusion indicated here is that the personal narrative around a sense of personal agency, and self-efficacy in judging the characteristics of the uncertain environment provides ‘safety cues’ that add to the individual’s protective frame (Apter, 1992) in specific settings. In terms of decisions of safety and risk, positive safety cues that add to the ‘protective frame’ may unconsciously bias people towards perceived *opportunities* rather than away from *threats*.

These findings provide weight towards unconscious bias effects for risk-based decisions in other leisure and tourism contexts, where risk perceptions and risk reduction strategies result from a dialogue between a participant’s risk expectations and personal experience, aligning it to the expert-novice differences observed in this mountaineering context. Indeed, tourism activities facing more random and indiscriminate risk such as dark tourism, sex tourism or unsupported travel to potential natural disaster zones are in some senses analogous in their uncertain outcomes to the avalanche terrain of this study, drawing research links to a range of biases and motivational factors.

Landrø et al. (2020) report the breadth of work undertaken worldwide on decision models and aids to enhance decision-making, while finding that these are not widely employed by experts, who adopt more intuitive, analytical and integrated approaches, echoing the work of Zsombok and Klein (2009) on NDM. This puts an onus of responsibility on policy and training programmes in adventure leisure to acknowledge the complex nature of unconscious bias influences, as well as to facilitate the delicate transition from novice to expert decision maker. Indeed, if awareness and attentiveness to heuristic safety cues can be fostered, balanced with pedagogies that develop analytical and knowledge-based approaches (modelling expert decision-making), then hopefully participants will be better equipped

for critical decision-making in complex, dynamic and high-risk domains. The dual contexts of unstructured leisure participation and professional leadership in a leisure setting add separate emphases to how training and awareness for decision strategies might be approached, given the very different interpretations of the environment found between different expertise levels and roles. The recommendations that we make to enhance situational and intrapersonal awareness and critical pedagogy of training programmes contribute to the debate developed by Page et al. (2005) and Olivier (2006) around codes of conduct across the adventure sector, and of Cannon-Bowers and Bell (2009) to develop effective decision-making strategies.

It seems certain that this debate around the influence of expertise, uncertainty and risk-mitigation strategies in the decision-making process can be expanded beyond the narrow realm of avalanche decision-making in Scottish Winter Mountaineering. Yet, this context provides a powerful example of decision-making conditions with high consequences, ambiguous information and weak feedback properties. Risk contexts exist throughout broader leisure settings that warrant further enquiry. In any higher-risk leisure setting, a fundamental balance is at play between objective 'known' facts or cues, and the subtle and unconscious level at which perceptual or situational factors such as safety frames or other heuristic biases influence decision-making.

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No potential conflict of interest was reported by the authors.

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