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Risk Judgments in Climbers: The Role of Difficulty, Meteorological Conditions, Confidence and Appropriate Tools

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ABSTRACT

Risk perception among climbers is a factor that can contribute to injury prevention. The purpose of this study was to analyze how expert climbers make judgments about potential risks to their safety. Specifically, we studied how climbers combine the available information on environmental conditions and personal resources in order to arrive at risk judgments. Sixteen distinct scenarios were presented to 134 climbers, and their risk perception related to each situation was recorded. Findings revealed that all variables were highly relevant for determining risk perception. When all variables were present at the same time, confidence was found to minimize the perception of risks caused by environmental conditions, such as difficult climbing. We conclude that an understanding of how expert climbers combine relevant information in order to judge risk can offer ways for them to take more effective preventive measures against injuries, specifically to identify hazards and their combined effects.

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In the context of *lifestyle sports* (Green, Thurston, & Vaage, 2014; Wheaton, 2010), participants in high-risk or adventure sports (Breivik, 2010; Fletcher, 2008) expose themselves to the risk of serious injuries that can lead to disability or even death (Hasler et al., 2009; Schoffl, Morrison, Schoffl, & Küpper, 2012). Mountain sports and leisure activities done in the outdoors have become increasingly popular in recent years (Brymer & Schweitzer, 2013; Furman, Shooter, & Schumann, 2010). It is estimated there are 100 million high-altitude tourists annually (Burtscher & Ponchia, 2010). U.S. national parks have seen an increase in recreational visits, reaching 281 million visits in 2010, and the practice of outdoor sports is expected to increase with climate change, improved access to outdoor areas, lower equipment costs, and the improved provision of courses and expert guides (Mort & Godden, 2011). Although only a small percentage of visitors to these parks may reach high altitudes or engage in high-risk sports, there is an enormous population taking part in outdoor activities. Q1

It is not surprising that this increased number of mountaineers and tourists has led to a steady increase in the occurrence of injuries and high-altitude related illnesses. This phenomenon has been observed in different countries (e.g., France, Switzerland, the United States) and mountain ranges (e.g., the Himalayas, the French Alps, Yosemite National Park and National Parks in Utah and Alaska) (Gonggalanzi et al., 2014; Heggie & Admunson, 2009). Therefore, the identification of the factors involved in causing such injuries is of great Q2 Q3

CONTACT Andres Chamarro andres.chamarro@uab.cat Q4 interest (Deroche, Stephan, Woodman, & Le Scanff, 2012; Hootman, Dick, & Agel, 2007) to those seeking to foster improved injury prevention measures. Some of these factors may influence how people perceive risks and make their decisions accordingly. The safety equipment and sporting goods industries may be interested in helping climbers to manage these risks. Managing risks is especially challenging in the case of novice outdoor enthusiasts who engage in climbing but are not aware of the range of variables that may affect their activity. It is also important for high-level climbers performing extremely difficult climbs or for expeditions to remote mountains, where accidents garner the greatest media coverage (Gagnon, Stone, Garst, & Arthur-Banning, 2016). Another group especially concerned with risk factors are mountain guides, who guarantee tourists' access to challenging ascents (International Federation of Mountain Guide Associations, 2016). Thus, the purpose of this study was to analyze how climbers combine all the available information related to environmental and personal conditions when arriving at judgments about risk. Anderson's functional theory of cognition (1996) was used here because it allows for a description of the judgment that results from combining different pieces of information. Drawing on this theory, we could identify how a variety of pieces of partial information are combined to come to a final risk judgment.

Literature review

Causes of injuries in mountain sports

Several groups of researchers have identified distinct factors that contribute to injuries resulting from mountain sports and outdoor leisure activities. For example, in downhill skiing and hiking, sudden cardiac arrest is the most frequent cause of death due to the combination of the body's unfamiliarity with physical activity at a high altitude and insufficient food and fluid intake (Burtscher & Ponchia, 2010). Among other risk factors associated with injuries identified by Hasler et al. (2009) are personal readiness for risk, snow type, poor weather, helmet usage, and a lack of familiarity with new ski equipment. In the case of mountaineering, including climbing, Chamarro and Fernández-Castro (2009) identified four important contributing risk factors: environmental events, such as difficulty, weather, and mountain conditions; equipment; physical status, mainly fatigue; and behavior, mainly errors and time pressure. Mort and Godden (2011) and Schöffl et al. (2012) conducted reviews of injuries in mountain and wilderness sports and concluded that for climbers, falling on routes of lower difficulty was the main risk factor. In short, a combination of personal, environmental and sport-specific requirements is associated with the occurrence of injuries.

Risk judgment and decision making

The amount of available knowledge regarding risk factors for climbers has increased and has become more precise over time. For example, when planning their routes, climbers now have access to websites with accurate and detailed information about terrain exposure, climbing difficulties, and weather forecasts. However, there has been limited research about how this information is used to estimate potential risks, which is significant because identifying risks often represents a prerequisite for participation in mountain sports. A closer look at these processes is necessary for two reasons: (a) the successful identification of potential risks can prevent climbers from exposing themselves to situations for which they are not prepared and is an essential factor in the choice of appropriate preventive actions (e.g., changing the route if the weather changes); and (b) novice mountaineers, who may have difficulties identifying potential risk factors, would benefit from education on decision-making abilities (McCammon & Hägeli, 2007). Slovic (1987) popularized the term "perceived risk" to describe this kind of assessment of hazards.

For Breivik (2010), risk perception is affected by social and cultural factors (i.e., values transmitted by the family, friends or teammates) and by individual beliefs of rationality and self-control. Elsewhere, Dawson, Johnson, and Luke (2012) have highlighted the importance of taking into account the difficulties involved in assessing the risk posed by combined hazards because lay people may not be readily able to identify a combination of hazards in different domains as a real risk. For instance, a novice outdoor tourist may have difficulties realizing that a change in weather conditions (e.g., increased wind or low temperature) may be serious when he or she is not wearing protective garments and proper shoes. This is especially relevant in the case of climbing, where erroneous risk perception and inappropriate decision making can produce severe consequences (e.g., injuries).

Climbing is among the most rapidly expanding lifestyle sports, with ever more participants and growing popularity. Climbing has evolved considerably since its origins and currently encompasses modalities such as bouldering, top-roping, traditional climbing, indoor speed climbing, and ice climbing. It is also intertwined with other lifestyle sports such as hiking and mountaineering (Gagnon et al., 2016).

The relevance of risk perception in this sport has been stressed by outdoor educational organizations (Raynolds, Gerzon, Blair-Smith, Gordon, & Garrett, 2007), who have underlined the centrality of understanding how to assess potential risks, making correct judgments, and taking effective decisions as elements of educational programs on taking calculated risks in an appropriate manner.

From a psychological point of view, we should consider that risk estimates are usually carried out by people in situations of *bounded rationality* (Simon, 1987), as in the case of incomplete information or under time pressure. In other words, the climber's estimate as to the advisability of continuing the ascent may be affected by his or her access to weather predictions or by fatigue. Under these circumstances, judgments usually become intuitive and are part of so-called System 1: a cognitive system governed by habits whose operation is fast, automatic, effortless, associative, and emotional, a mechanism that is difficult to control or modify. That is in contrast to System 2: a slow, reflective, rule-based, and controlled system (e.g., Kahneman, 2003).

In studies of leisure activities, Furman et al. (2010) found that backcountry skiers preferred automatic heuristics (fast and intuitive decisional rules based on System 1) to rule-based decision tools (e.g., checking snow conditions, slope inclination and orientation, and then selecting the safer slope), as the latter are often slow and tedious and can yield ambiguous results. It may seem that climbers have to accept that no precise risk judgment is possible and that their only option would be to gain confidence in their intuitive estimations.

This approach seems to represent the point of view of explorers or climbers of the 19th or 20th centuries, when only limited information about ascents was available. Currently, with the proliferation and accessibility of information (e.g., online newspapers and personal blogs), this approach may be insufficient. In line with this change, Johnson (2006) suggested that knowing cues and rules of judgment may play a critical role by allowing athletes to cope efficiently with the complex demands of their sport. Rulence-Paques, Fruchart, Dru, and Mullet (2005) have also suggested that one possible variable contributing to sport performance might be the degree to which an athlete organizes and integrates knowledge using a decision-making scheme.

The functional theory of cognition

To define the psycho-cognitive laws of information processing and the integration of multiple stimuli to form judgments and make decisions, Anderson (1996) proposed the functional theory of cognition. The theory assumes that making judgments involves two different cognitive processes. First, the person engages in an evaluation process, giving a subjective meaning to each piece of available information. Second, the person must integrate all pieces of information to make an overall judgment. These mental operations are conditioned by personal resources and environmental strain.

The integration process can be executed according to an additive rule or a multiplicative rule. Integrating the information using an additive rule means that each piece of information contributes independently to risk perception, with the influence of one of the factors (e.g., an environmental factor) seen as independent from the influence of another (e.g., a personal factor). Integrating the information using a multiplicative rule means that the influence of one piece of information depends on the level of the other pieces of information; the risk perception of one factor can be strengthened or weakened depending on the risk perception of another factor. Therefore, the final perception of risk will be the result of either adding up or of multiplying the different factors. Obviously, under a multiplicative rule a single factor has a great influence on risk perception, increasing or diminishing it quicker than it does under an additive rule.

The functional theory of cognition is typically tested using the factorial survey method, which combines the advantages of an experimental design with those of survey research (Shooter & Galloway, 2010). In factorial survey studies, subjects receive a variety of hypothetical vignettes describing specific circumstances. These vignettes are constructed based on factors thought to influence judgment, and the subjects are asked to indicate how the decision should be made using a rating scale. Factorial surveys have been employed to understand real-world decision-making activities, with the goal of developing methods to enhance the decision process (Shooter & Galloway, 2010; Wallander, 2009). In the field of leisure research, Furman et al. (2010) tested various reported avalanche condition forecasts and their influence on decision making by asking participants the likelihood that they would ski a slope under distinct conditions.

In summary, Anderson's functional theory of cognition (1996) allows for a description of judgments made as a result from combining different pieces of information. Drawing on this theory and its description of evaluation and integration processes, we were able to identify how a variety of pieces of partial information are combined to come to a final risk judgment on the different situations the climber may cope.

The present study

Rationale for the study

The few studies that have analyzed risk perception and decision making in sports have often focused on the fast, intuitive, and automatic processes used by athletes, either in the absence of information or with minimal data processing (Bennis & Pachur, 2006; Furman et al., 2010). However, a deliberate and rule-based process of combining available environmental and personal information for risk perception and decision making is possible. Based on the environmental, sport-specific, and personal risk factors identified by Chamarro and Fernández-Castro (2009) in mountaineering, Chamarro, Rovira, and Fernández-Castro (2010) analyzed the way hikers (walkers along specific trails, not needing specific equipment and skills) make judgments. These judgments weigh the available information as to difficulty (i.e., the strength and stamina necessary for progression over the terrain), fatigue, confidence, and time pressures (i.e., temporal constraints to reaching the shelter or turning back). These variables represent some elements of the hiker-environment-sport interaction and may be key components in hikers' appraisals regarding situational threats and personal resources. Results showed that confidence and fatigue (the individual variables) operated as independent entities, which then interacted with difficulty and time pressure (sport and environmental variables, respectively) to determine risk perception. The hikers' confidence in their abilities appeared to contribute to protecting them against health threats (e.g., falls) when considering other negative components, such as difficulty or time pressure. Under these circumstances, being confident diminishes risk perception until the emergence of a new threat. This effect may be useful for hiking because it allows the hiker to concentrate on the path and its difficulty or on time pressure, and it ensures performance. However, this confidence also can represent a serious bias when hikers are unconcerned about potential but real safety threats missed on this account. Chamarro, Martí, Rovira, Carola, and Fernández-Castro (2013) studied how backcountry skiers, that is, recreational skiers ascending mountains with skis and descending outside areas under the daily control of ski resorts, evaluate the risk associated with avalanche hazards. Participants were invited to evaluate information about terrain exposure (e.g., gradient), avalanche danger (specified by the avalanche forecast), and the availability of safety gear (probes, shovels and beacons for self-rescue). Even when more information was made available to the participants (e.g., knowledge of terrain exposure, the avalanche forecast, and the presence of safety gear), not all the variables were given weight in assessing risk. In fact, it appears these skiers limited their risk judgments to the combination of only two factors: terrain exposure and the avalanche forecast or the avalanche forecast and the availability of safety gear. In other words, available information seems to be treated as "substitutable" data points (Guillet, Hermand, & Mullet, 2002) that are combined through additive rules (i.e., the sum of perceived risk is equal to the sum of hazards). The above results show that people tend to integrate environmental or sport-related factors following an additive rule, but when individual factors are considered, multiplicative rules of integration appear, and a more complex pattern of risk assessment appears.

Furman et al. (2010) also suggested that safety would not be promoted by adding more information, as skiers preferred to use heuristics instead of complex data. But when deliberative decision processes are not practiced, complexity can lead to the use of heuristics that can minimize the perception of risk. In this sense, greater familiarity with the deliberative processes that experts carry out when judging risk perception provide learning cues to improve decision making processes in climbing contexts, helping participants to integrate more available information, and use heuristic rules in a more prudent way.

Objectives and hypotheses

Based on previous findings, the objective of this study was to analyze how expert climbers combine available information related to environmental conditions and personal resources to arrive at their risk judgments. Expert climbers do not generally initiate their ascent without consulting route descriptions, equipment requirements, and weather conditions, and they tend to do so after thoroughly assessing their own physical and psychological climbing skills. However, the specific rules climbers use to conduct their deliberate risk assessment and guide their decision-making before and during their ascents are not yet fully understood.

Perceived risk is a combination of information related to personal, environmental, and sport-specific variables. For our study, four key informational variables were used: difficulty, meteorological conditions, having the appropriate tools, and confidence. Difficulty and meteorological conditions are two of the environmental events often mentioned by climbers as key elements to progression and that have proven to be risk factors for injury (e.g., Mort & Godden, 2011). In addition, having the appropriate tools is fundamental for ascents, and their absence is an important risk factor (Chamarro & Fernandez-Castro, 2009). Furthermore, confidence may influence other negative situational factors (Chamarro et al., 2010). According to previous research (French, Marteau, Sutton, & Kinmonth, 2004), there is evidence that some hazards act together. This is also true in the case of climbing, where two or more factors can work in concert. For example, climbers may traverse difficult sections combined with poor environmental conditions, such as broken or unstable rock, or they might face these sections without the appropriate tools. Usually, the effects of these environmental, sport-related, and personal factor combinations are multiplicative (Chamarro et al., 2010). In other words, the risk arising these combined hazards is greater than the sum of the risks attributable to each one. In light of the above, it was hypothesized that:

- The perception of risks stemming from the difficulty of climbs and from meteorological conditions (environmental conditions), as well from as access to the appropriate tools and the climber's confidence (personal resources), would follow a multiplicative pattern.

However, others hazards act in an isolated way, as occurs when well-equipped, experienced climbers are faced with snowfalls, and in these cases the effects are additive. The risk of this new event is added to previous risk but does not represent an exceptional threat. Previous research suggests that the combination between situational variables will be additive (Chamarro et al., 2013). According to this, it was hypothesized that:

- The perception of risks arising from the available environmental information (difficulty and meteorological conditions) available during climbing will follow an additive pattern.

Materials and methods

Participants

The sample comprised 134 climbers (16.3% female) applying to become members of the Spanish Climbing National Team and their instructors. Their average age was 32.59 years ($SD = 8.01$), with an age range from 18–56. Participants' average climbing experience was 10.79 years ($SD = 8.01$). All participants were informed about the objectives of the study and gave their consent. As no one declined participation and all respondents completed the full questionnaire, there were no missing data. Following Ericsson and Charness (1994), we consider that the level of abilities and skills allowing candidates to be preselected for national teams and the mean experience of around 10 years would allow our participants to be reasonably deemed experts. This criteria is stricter that the one used by earlier studies (e.g., Monasterio, 2005), which considered climbers with a mean experience of five years to be "serious, committed and experienced climbers" (p. 6).

Measures

Athletes provided their age, gender, and years of experience. Simulated scenarios were used to represent the kinds of information that participants may be confronted with during an ascent. Sixteen scenarios were designed using the systematic combination of the four variables, each having two possible values: difficulty (easy vs. difficult), meteorological conditions (good vs. bad weather), appropriate tools (having vs. not having), and confidence (high

Table 1. Variables and rating scales.

Variable	Item and response scales
Independent variables	
Difficulty	"The way is easy"/"The way is difficult"
Meteorological conditions	"The weather is fine"/"The weather is bad"
Climbing tools	"You are carrying the appropriate tools"/ "You don't carry the appropriate tools"
Confidence	"You feel confident"/"You don't feel confident"
Dependent variables	
Worry	0 hardly worried at all – 10 extremely worried

vs. low) (Table 1). According to Peters, Slovic, Hibbard, and Tusler (2006) we used worry as the dependent variable to assess risk perception. Worry is an internal feeling and common response to perceiving risk when becoming aware of uncertainties and dangers, and it is associated with the likelihood of taking preventive actions. Each scenario was presented on a separate sheet of paper, and participants were asked to rate to what extent they would feel worried under the specific conditions. For example, the scenario that corresponds to the most unfavorable conditions, or in other words features the negative pole of all four variables, is the following: "You are doing an ascent with your habitual teammates. The way is difficult. The weather is bad. You aren't carrying the appropriate tools. You don't feel confident."

Design

Based on this simulated scenario methodology, the two different levels for each variable gave rise to a within-subject experimental design of 2 × 2 × 2 × 2, in which the scenarios were presented randomly. The use of this within-subject design ensured that all the participants experienced all the conditions, allowing us to control for possible individual differences.

Procedure

The procedure consisted of two phases (Anderson, 1996). In the first, the participants familiarized themselves with the task at hand by responding to six scenarios. Two of these conditions represented the most extreme levels to avoid the ceiling and floor effect in the remaining scenarios, and the other four were extracted at random from the 16 experimental possibilities. During this phase, the participants could ask questions to clarify any confusion about the scenarios. Data obtained during this first phase were not used in the subsequent analyses. In the second experimental phase, all 16 scenarios were randomly presented to each participant. Participants indicated their degree of worry in each scenario on a Likert scale (from 0 *hardly worried at all* to 10 *extremely worried*).

Data analysis

We conducted an analysis of variance (ANOVA) for repeated measures, with difficulty (low/high), meteorological conditions (fine weather/bad weather), carrying appropriate tools (carrying/not carrying appropriate tools), and confidence (confident/not confident) as variables. To check for interactions, we used post-hoc pairwise tests with Bonferroni adjustment for multiple comparisons to determine how changes in worry level related to one factor were affected by changes in the other variables. Using this analysis, and according to Anderson (1996), we were able to determine, first, if the chosen factors were relevant for

Table 2. Analysis of variance for the repeated measures in the 2 × 2 × 2 × 2 design (difficulty, meteorological conditions, carrying the appropriate tools, and confidence) for determining the perceived level of worry.

Source	*df*	*F*
Difficulty	1	306.67**
Difficulty within-group error	133	(6.13)
Meteorological conditions	1	240.24**
Meteorological conditions within-group error	133	(5.39)
Carrying the appropriate tools	1	322.40**
Carrying the appropriate tools within-group error	133	(5.64)
Confidence	1	302.38**
Confidence within-group error	133	(8.68)
Difficulty by Meteorological conditions	1	12.57*
Difficulty by Meteorological conditions within-group error	133	(2.51)
Difficulty by Carrying the appropriate tools	1	13.10*
Difficulty by Carrying the appropriate tools within-group error	133	(2.12)
Difficulty by Confidence	1	0.19
Difficulty by Confidence within-group error	133	(2.25)
Meteorological conditions by Carrying the appropriate tools	1	9.59*
Meteorological conditions by Carrying the appropriate tools within-group error	133	(2.57)
Meteorological conditions by Confidence	1	13.97**
Meteorological conditions by Confidence within-group error	133	(2.40)
Carrying the appropriate tools by Confidence	1	9.41*
Carrying the appropriate tools by Confidence within-group error	133	(2.58)
Difficulty by Meteorological conditions by Carrying the appropriate tools	1	0.061
Difficulty by Meteorological conditions by Carrying the appropriate tools within-group error	133	(1.95)
Difficulty by Meteorological conditions by Confidence	1	2.05
Difficulty by Meteorological conditions by Confidence within-group error	133	(1.69)
Difficulty by Carrying the appropriate tools by Confidence	1	1.30
Difficulty by Carrying the appropriate tools by Confidence within-group error	133	(1.96)
Meteorological conditions by Carrying the appropriate tools by Confidence	1	8.09*
Meteorological conditions by Carrying the appropriate tools by Confidence within-group error	133	(2.22)
Difficulty by Meteorological conditions by Carrying the appropriate tools by Confidence	1	0.60
Difficulty by Meteorological conditions by Carrying the appropriate tools by Confidence within-group error	133	(1.95)

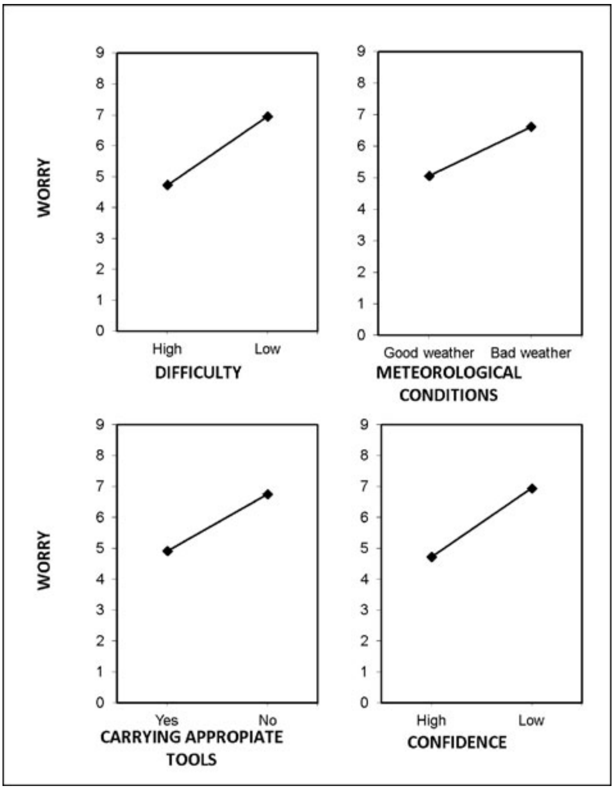
Note: values enclosed in parentheses represent mean square errors. * $p < 0.05$; ** $p < 0.001$.

judgment (significant principal effects of each factor) and, second, if the information was combined in an additive way (i.e., nonsignificant interactions: the more variables at play the greater the effect in the resulting judgment) or a multiplicative way (i.e., significant interactions: the effect of some of the variables is multiplied when combined with certain additional variables).

Results

The mean perceived worry level in the most favorable scenario was 1.86 (SD = 1.30), and it was 9.69 (SD = 2.00) in the most unfavorable one, suggesting any floor or ceiling effects could be discarded. The analysis of variance (see Table 2) indicated the main effects of the four variables were significant. Figure 1 shows how higher levels of perceived worry were related to a high degree of difficulty ($F[1, 133] = 306.67, p < .001$), bad weather ($F[1, 133] = 240.24, p < .001$), not carrying the appropriate tools ($F[1, 133] = 322.40, p < .001$), and a low level of confidence ($F[1, 133] = 302.38, p < .001$).

According to hypothesis 1, integration of personal factors with environmental factors should be multiplicative (i.e., a significant interaction), when judging worry. Table 1 shows a significant triple-interaction (multiplicative effects) between meteorological conditions,



Q5 **Figure 1.**

carrying the appropriate tools, and personal confidence, but the interaction between confidence and difficulty is nonsignificant, demonstrating an additive pattern of integration.

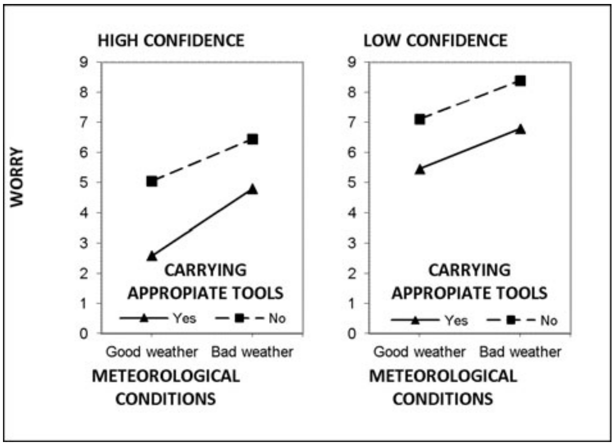
According to hypothesis 2, environmental and sport-related factors should lead to additive integration (i.e., non-significant interaction). Table 1 shows a significant interaction (multiplicative effects) between difficulty and meteorological conditions and between difficulty and carrying the appropriate tools. The combination between meteorological conditions and carrying the appropriate tools should be interpreted in the context of the significant triple-interaction mentioned above.

To ease comprehension, the results of the significant triple interaction will be reported first, and results concerning difficulty factor, implied in second-order relations, will be explained in groups below.

Relationship between meteorological conditions, carrying the appropriate tools and confidence

Figure 2 presents the relationship between meteorological conditions and carrying the appropriate tools at each level of confidence and their roles in determining the degree of worry.

With a low level of confidence (right panel), the meteorological conditions showed an additive relationship. Worry increased with bad weather, both when carrying the appropriate tools ($F[1, 133] = 66.83$, $p < .001$) and when not ($F[1, 133] = 64.87$, $p < .001$). Indeed, the mean difference in reported worry between having bad and good weather when carrying the appropriate tools was 1.34 (CI: 1.01, 1.66), whereas it was 1.27 (CI: 0.96, 1.59) in the absence of



Q6 **Figure 2.**

adequate tools. In addition, not carrying suitable tools increased the perceived risk under all meteorological conditions ($F[1, 133] = 110.72, p < .001$ for good weather; $F[1, 133] = 119.38, p < .001$ for bad weather). The mean difference in degree of worry between not carrying or carrying the appropriate tools when there was good weather was 1.66 (CI: 1.35, 1.97), while in bad weather it was 1.60 (CI: 1.31, 1.89).

At a high level of confidence (left panel), the meteorological conditions had a significant interaction with carrying the appropriate tools, showing a multiplicative relationship. A higher decrease in the degree of worry was produced by better meteorological conditions when carrying the appropriate tools ($F[1, 133] = 234.04, p < .001$) in comparison to not carrying them ($F[1, 133] = 92.18, p < .001$). In this sense, the mean difference of worry between bad and good weather when carrying adequate tools was 2.2 (CI: 1.92, 2.49), whereas it was 1.41 (CI: 1.12, 1.70) in the absence of appropriate tools.

Relationship between difficulty and each of the other three variables (meteorological conditions, carrying the appropriate tools and confidence)

The left panel of Figure 3 shows the level of worry as a function of difficulty and meteorological conditions under a multiplicative rule. The mean difference of worry between bad and good weather was 1.31 (CI: 1.08–1.54) when easier routes were presented, but it was 1.80 (CI: 1.55, 2.05) for difficult climbs. It is worth highlighting that bad weather increased worry at all difficulty levels. However, according to the lack of overlap between confidence intervals of both mean differences, this increase was significantly higher when the climb was difficult: Furthermore, the mean differences of worry between the difficult and easy levels were 1.63 (CI: 1.39, 1.87) and 2.12 (CI: 1.85, 2.38) for good and bad weather, respectively. Therefore, at all levels of meteorological conditions, climbing difficulty was found to increase worry and, according to the lack of overlap between confidence intervals of both mean differences, especially when the weather was bad.

The central panel of Figure 3 shows the level of worry as a function of difficulty and carrying the appropriate tools, under a multiplicative rule. The mean difference of worry between not carrying and carrying the appropriate tools was 1.61 (CI: 1.382, 1.85) for easy climbs and 2.07 (CI: 1.83, 2.31) for difficult ones. We observed that not carrying the appropriate tools increased worry at both levels of difficulty, and according to the lack of overlap between confidence intervals of both mean differences, with significantly higher concern arising when climbs were more difficult, as equipment is essential for these ascents.

The mean differences of worry between the difficult and easy climbs were 1.65 (CI: 1.41, 1.88) when carrying the appropriate tools and 2.10 (CI: 1.84, 2.36) in the absence of suitable tools. Whether or not individuals were carrying the appropriate tools, difficult climbs increased worry; however, and according to the lack of overlap between confidence intervals of both mean differences, this was especially true when lacking adequate tools.

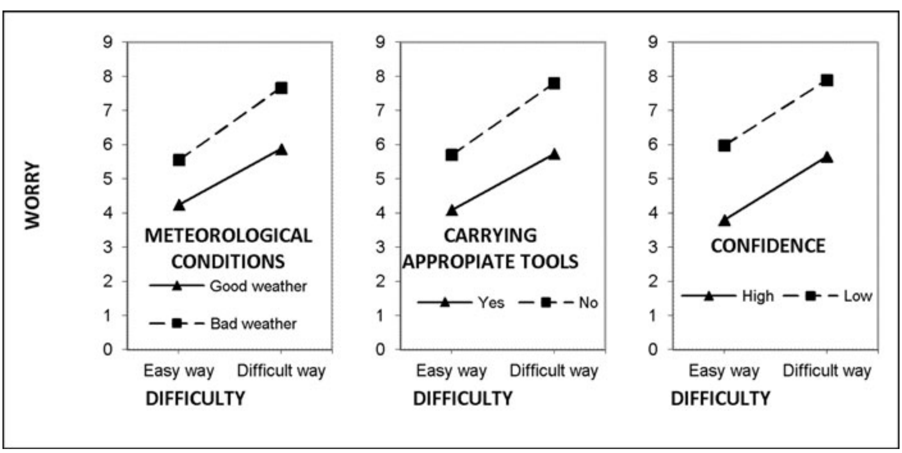
The right panel of Figure 3 shows the additive relationship that exists between difficulty and confidence in determining worry. The mean differences in worry between difficult and easy climbs were 1.85 (CI: 1.60, 2.09) and 1.90 (CI: 1.66, 2.15) when there were high or low levels of self-efficacy, respectively. According to the overlap between confidence intervals of both mean differences, greater difficulty resulted in similar increases in the degree of worry at both low and high self-confidence levels: Finally, the mean difference of worry between low and high self-efficacy was 2.19 (CI: 1.90, 2.47) when climbs were easy and 2.24 (CI: 1.96, 2.52) when they were difficult. According to the overlap between confidence intervals of both mean differences, at all levels of difficulty having low self-efficacy uniformly increased the degree of worry.

Discussion

Summary of the findings

The purpose of this study was to ascertain how climbers integrated difficulty, meteorological conditions, carrying the appropriate tools and confidence in their assessments of health threats (i.e., how they use these factors to make risk level judgments).

As highlighted by previous reports (Chamarro & Fernández-Castro, 2009; Chamarro et al., 2010), all four factors considered in the present study were highly relevant in determining risk perception in climbing. In fact, the significance of the main effects indicated that the different



Q7 **Figure 3.**

levels designed for each variable gave rise to differing degrees of perceived risk; as expected, the risk is perceived to be highest when the difficulty is high, the weather is bad, the athletes do not have the appropriate tools, and in situations of low confidence. According to Anderson, (1996), variable risk evaluation outcomes appeared to validate the differential scenarios that were considered, which means that expert climbers were be able to recognize the described scenarios and take note of the health threats they pose.

In addition, the interaction pattern between the selected variables is important. According to our results, when confidence is low, meteorological conditions and carrying tools contribute with equal force to an increased perception of risk. In contrast, when confidence is high, perceived risk is particularly low when climbers have the appropriate tools and meteorological conditions are good (i.e., the most favorable situation). But when conditions are less favorable, the perception of risk is maintained despite having high confidence. This makes us think that confidence and perception of risk are two aspects that expert climbers are well able to differentiate.

Nonetheless, when all conditions are favorable, an overconfidence effect could contribute to a potentially dangerous minimization of risk perception, because even safe situations can present natural hazards. Thus, this suggests that climbers may be unable to perceive risks in the absence of obvious indicators of difficulty or meteorological change. In these situations of low perceived risk and high confidence, climbers might make decisions without considering alternative options. For instance, climbers might decide to engage in a difficult, exposed ascent without considering escape routes to take if bad weather appears. Nevertheless, these results confirm our first hypothesis by highlighting the interactive relationship between meteorological conditions, carrying appropriate tools, and confidence.

Since a multiplicative relationship was observed between meteorological conditions, carrying the appropriate tools and difficulty, the second hypothesis was rejected. Generally speaking, perceived risk rises according to the severity of the meteorological conditions or not carrying suitable tools, but when the difficulty is high, the levels of perceived risk are at their highest. Thus, when one of these conditions has already worsened for climbers, a deterioration in another is then perceived as more serious, which exponentially augments the level of worry. However, this relationship does not operate when confidence level interacts with difficulty. This nonmultiplicative pattern seems to confirm the independent minimization effect that confidence has over the risk perception due to the presence of environmental variables. Thus, even though confidence can allow climbers to cope with challenging or hazardous environmental conditions, it has a differential role in triggering perceived risk. So, confidence may play a dual role, as a protector but also as a potential problem, when it turns into overconfidence; this may undermine the wisdom of seeing multiple risks. This kind of relationship between personal and environmental variables has been proven in studies of similar recreational outdoor activities, including hiking (Chamarro et al., 2010) and backcountry skiing (Chamarro et al., 2013). When the strain of a situation is high (such as in a difficult climb with adverse meteorological conditions), the level of risk perceived largely depends on personal confidence. Thus, a climber's ability to cope with difficulties, tool limitations and/or environmental conditions may be considered evidence of what Guillet et al. (2002) called "psychological robustness", which is part of the basic set of decision-making skills for outdoor leaders (Raynolds et al., 2007). This seemed to be a critical ability presented by our highly skilled sample. However, as discussed earlier, this effect may be dangerous if climbers do not simultaneously adhere to preventive rules and take safety precautions.

In contrast to less hazardous situations (e.g., hiking), the multiplicative pattern between meteorological conditions and carrying the appropriate tools and difficulty suggests that environmental conditions, difficulty and progression/safety tools may not be "substitutable entities" in climbing. That means that in climbing, rule-based and deliberate risk judgments appear to be useful for coping with the complex demands of the activity. Additionally, snap judgments made without giving consideration to these combined effects may have more serious consequences when compared to less hazardous outdoor activities. Nevertheless, when situational demands are not challenging, expert climbers may use simple judgments. Therefore, they might only employ deliberate risk judgments when the demands are high.

Limitations

This study presented some limitations. The sample consisted of only selected, highly skilled climbers, so a replication with less-skilled climbers might be needed, and the study could be expanded to include other recreational outdoor activities such as mountain-biking, snowboarding, and skateboarding (e.g., Breivik, 2010). Another limitation relates to the broad age range of the study participants. Thus, further studies may wish to attempt to replicate our results with a more limited age range.

Due to the inexistence of previous studies with the population of reference, sample sizing and power analysis were not conducted when this study was designed. However, future studies could use our results as reference values for sample sizing and power estimation.

Implications and conclusions

Our findings have demonstrated how expert climbers who are exposed to hazards appraise a potential risk. Our evaluation of these individuals involved the analysis of variables that represent different components of the climber-activity-environment interaction, highlighting how these factors together shape risk perception. Therefore, the differential combination of available information to make risk judgments suggests that expert climbers can implement deliberate cognitive skills when making risk appraisals. From our viewpoint, these results indicate that deliberate processing may be used when expert climbers must deal with complex risky situations. For this reason, the study of risk perceptions and decision-making is a promising tool for enhancing safety in lifestyle sports and might contribute to improvements in the comprehension of the rational behavior behind prudence and self-control (Breivik, 2010).

For us, from an educational and preventive standpoint, when the activity implies a risk of serious injury, it is important not only to train climbers in technical abilities but also to teach them how to identify environmental and sport specific-risks, and how to develop personal resources such as confidence. However, as Furman et al. (2010) assert, we must keep in mind that confidence can evolve into overconfidence and contribute to the erroneous minimization of risk. In this sense, we think it is important to learn that feeling confident is desirable for a good performance, but that it must always be accompanied by an adequate perception of the risk.

Additionally, identified risk judgments by experts could then be used as basic algorithms for educational courses on decision making in outdoor sports, which should equip participants to respond when they are faced with changes in environmental conditions or decreased personal resources, such as a loss of confidence. Consequently, they could learn to deliberately activate a reflective rule-based way of thinking to maximize their safety and performance. This is especially true for novice climbers, who may not be aware of the complex demands of the activity and the potential interaction between hazards; that is, the enormous increase in risk resulting from changes in environmental conditions when not carrying appropriate tools and experiencing a loss of confidence.

In summary, our findings suggest that when risk evaluation is performed, it is important to take into account not only the environment itself but also its interaction with sport-specific demands and personal resources, especially confidence. In this regard, implementing fundamental rules to follow in complex situations might lead to greater safety and better performance.

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