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To cite this article: Philip A. Ebert & Ian N. Durbach (2022): Expert and lay judgements of danger and recklessness in adventure sports, Journal of Risk Research, DOI: [10.1080/13669877.2022.2091001](https://doi.org/10.1080/13669877.2022.2091001)

To link to this article: <https://doi.org/10.1080/13669877.2022.2091001>



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Published online: 28 Jun 2022.



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# Expert and lay judgements of danger and recklessness in adventure sports

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## ABSTRACT

We investigate differences in perceived danger and recklessness judgements by experts (experienced skiers,  $N = 362$ ) and laypeople ( $N = 2080$ ) about participation in adventure sports across the same judgemental task using a third person perspective. We investigate the relationship between danger and recklessness and the extent to which fatality frequency, as well as other contextual factors such as gender, dependants, competence, and motivations of the sports participant affect expert and laypeople judgements respectively. Experienced skiers gave lower overall danger and recklessness ratings than non-skiers. Experienced skiers' judgements were also more sensitive than non-skiers' to variations in the fatality rate of the activity and the competence level of the participant, yet were less sensitive to whether the event was done for external benefit such as a charity. Recklessness judgements were overall more sensitive to changes in activity descriptions than danger judgements. Our findings support the emerging picture of adventure sports participants as rational and sensitive to risk-relevant features rather than somehow pathological in their risk perception.

## ARTICLE HISTORY

Received 2 October 2020

Accepted 16 April 2022



## KEYWORDS

Risk perception;  
uncertainty;  
decision making;  
moral dimension of risk;  
adventure sports

## Introduction

Research has suggested that experts differ from laypeople in their risk judgements (Slovic 1987; Bostrom 1997; Sjöberg 1998; Slovic 2000; Siegrist, Hubner, and Hartmann 2018). With knowledge and experience, people tend to focus more on objective measures of hazard and less on qualitative and affective factors (see, however, Rowe and Wright 2001). This poses an initial challenge for explaining why people take up and persist with adventurous sports activities: if greater expertise brings and increasing awareness of objective risk, why do people persist and often become increasingly devoted to activities that are, at least some of the time, objectively dangerous?

Early explanations focused on sensation- or thrill-seeking characteristics of the individual (Zuckerman 1979; Zuckerman 2007), but these were strongly criticized on at least two grounds: first, they are 'deficit-based', in the sense that the behaviour is theorized to fill some gap or

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deficiency in the participant's life (Brymer and Mackenzie 2016), and, second, they seem to imply that participants enjoy risk, defying a positive relation between perceived liking and safety that holds for almost everyone else (Stephensen and Martiny-Huenger 2021). Further, recent experimental findings suggest that adventure sports participants do not necessarily behave in a more risk-seeking or thrill-seeking manner than the general population in other contexts (Collard and Oboeuf 2013; Riddel and Kolstoe 2013). Moreover, the thrill-seeking approach sits uncomfortably with the precautionary behaviour of many dangerous sports participants who manage and minimize the risks they are exposed to (Celsi, Rose, and Leigh 1993; Holland-Smith and Olivier 2013; Woodman et al. 2013; Young et al. 2014).

Subsequent research focused instead on the positive aspects and personal benefits of engaging in adventurous sports, such as on emotion-regulation (Barlow, Woodman, and Hardy 2013; Castanier, Le Scanff, and Woodman 2011), on so-called flow states and peak performance (Boniface 2000; Kerr and Houge Mackenzie 2012; Boudreau, Mackenzie, and Hodge 2020), and on other types of positive experiences and values associated with adventurous activities (Ewert 1994; Loewenstein 1999; Brymer, Downey, and Gray 2009; Brymer and Gray 2010; Kerr and Houge Mackenzie 2012; Brymer and Schweitzer 2013a; Brymer and Schweitzer 2013b; Ebert and Robertson 2010; Ebert and Robertson 2013; Frühauf et al. 2017; Hetland et al. 2018). Other research identified personal, social and environmental factors that are independent of sensation-seeking traits and that affect domain-specific risk perception of adventure sports participants, such as self-efficacy (Llewellyn et al. 2008), optimism bias (Martha, Sanchez, and Gomà-i-Freixanet 2009; Groves and Varley 2020), physical exertion (Raue et al. 2017), social standing and positionality (Mannberg, Hendriks, and Johnson 2021), prior experience and familiarity (Furman, Shooter, and Schumann 2010; Leiter and Rheinberger 2016; Marengo, Monaci, and Miceli 2017), framing (Stephensen et al. 2021), and affect (Creyer, Ross, and Evers 2003). In addition, recently Stephensen and Martiny-Huenger (2021) showed that backcountry skiers exhibited a 'healthy positive relation between liking and perceived safety' i.e. the same risk patterns as everyone else, when assessing the risk of specific instances of their activity. However, somewhat surprisingly, no studies have directly compared adventure sports participant ('expert') and non-participant ('laypeople') judgements across the same judgemental tasks. If, as recent theories argue, there is nothing particularly mysterious or unusual about adventure sports participants' attitudes towards risk, then empirical risk judgements should be predictable using standard findings.

In this paper, we investigate risk judgements about adventure sports and compare judgements made by people with experience and those with no such experience. In particular, we examine whether expert skiers are more sensitive to objective risk measures like fatality rates, as would be predicted by standard results from risk perception (Slovic 1987; Siegrist, Hubner, and Hartmann 2018). We also assess whether risk judgements are influenced by information about perceived benefits, with risk judgements inversely related to perceived benefits, as would be predicted by the affect heuristic (Finucane, Alhakami, et al. 2000). We expect experts and laypeople to view different factors as important for determining the expected benefit of the activity. So, for example, contemporary accounts of adventure sports participation emphasise the centrality of being prepared and trained for the risky activity. Education and experience is a core part of being a *responsible* risk taker (Ewert and Hollenhorst 1994; Holland-Smith and Olivier 2013; Ebert and Robertson 2013; Groves and Varley 2020). Removing this factor is expected to lead to a larger increase in perceived risk and recklessness among experts than amongst laypeople. In contrast, we expect laypeople's judgements to be more sensitive to external or extrinsic benefits and disbenefits. We used whether the activity benefited a charity as an exemplar of external benefits, and having dependants as external disbenefits. In summary, we test whether differences in the way experienced and laypeople perceive the risk of an adventure sport activity can be explained using standard risk theory. If true this would support the notion that adventure sports participants view and react to risk in their

world in much the same way as everyone else does, as something to be managed and minimized by a combination of analytical and emotive processes (Stephensen and Martiny-Huenger 2021).

To investigate these questions, we presented participants with a series of specific instances of backcountry skiing scenarios involving a hypothetical skier. By manipulating the description of the events in question, we investigate which factors affect the judgements made by the two groups, and thus describe similarities and differences between them. Participants judged the danger associated with each scenario as well as how reckless a person would be in pursuing it—an evaluative judgement about whether taking certain kinds of risks are justified. We elaborate on the third person perspective in the next section, but essentially this framing is used to define a generic instance of a category-level activity, one that is necessary to evaluate the effect of expertise on the *same* judgemental task. After all, an expert who assesses how risky it is *for them* to ski a given slope evaluates a fundamentally different activity to a non-skier asked how risky it is *for them* to do the same.

We also take the opportunity provided by a relative abundance of laypeople to run an initial survey with an extended series of descriptions that investigate additional factors that may influence risk perceptions in this group. The male effect, the phenomena that male respondents tend to judge the risk lower than female respondents, has been extensively studied across different judgement tasks but not, as far as we know, for adventurous sporting activities (Flynn, Slovic, and Mertz 1994; Finucane, Alhakami, et al. 2000). However, not only are there recent studies that challenge such gender effects (Olofsson and Rashid 2011), adopting a third person perspective allows us to investigate if any gender effects are mainly due to the gender of respondent, the gender of the sports participant, or whether more complicated cross-gender effects can be identified (male respondent-female sports participant and vice versa).

Finally, why care about how adventurous sports are perceived, either by those who participate in them or those who do not? We can, broadly speaking, offer three reasons. Firstly, increasing numbers of people are taking up adventurous outdoor sports, and studies highlight the potential benefits of such outdoor activities. Misperceptions about their risk can lead to stereotyping of those who engage in the sport and might hinder more widespread participation. Secondly, services such as wilderness search-and-rescue operations, mountain weather information services, and avalanche forecasting services are often entirely or largely funded by public funds. These services provide information to engage with the relevant risks more responsibly but their preventive role may not be properly appreciated by the public. In this wider context public perceptions, including those who do not participate, matter. Thirdly, as authors from Loewenstein (1999) to Stephensen and Martiny-Huenger (2021) have stated, adventure sports offer an intriguing opportunity to study real-world activities that challenge standard conceptions of risky decision making. If part of the value of a theory is its ability to generalize, then testing those theories in these applied decision contexts is an important and valuable test.

## Survey 1

### Participants

We recruited a minimum of 80 respondents for each of the vignettes in Survey 1, based on an initial power analysis that 85 respondents would be sufficient to provide 90% power to detect a one-unit difference in mean response on a nine-point scale, assuming a conservative common standard deviation of 2 i.e. a 'moderate' effect size  $d = 0.5$ , and a type 1 error rate of  $\alpha = 0.05$ . With each respondent seeing a single vignette, in total we recruited 2166 respondents across the 24 vignettes used in Survey 1. Of these we received 2060 complete responses, an average of 86 respondents per vignette (minimum = 77, maximum = 102; due to the automated randomized allocation of respondents to vignettes).

Respondents were recruited using the *Prolific* platform, based on some evidence that it is preferable to Amazon Mechanical Turk (Peer et al. 2017; Palan and Schitter 2018; Gupta, Rigotti, and Wilson 2021). Given the nature of the vignettes, we restricted participation to native English speakers living in the UK. We paid each respondent £0.40 (averaging roughly £7.75 per hour<sup>1</sup>). The respondents' mean age, based on the mid-points of age categories, was 35.2, with substantial variation (21% 18–24, 35% 25–34, 22% 35–44, 15% 45–54, 7% 55–64, 1% 65+). Most respondents identified as female (1436 female, 612 male, 12 other). Very few respondents had any previous experience of any of the adventure sports used in the vignettes (6% skitouring, 3% big-wave surfing, 3% rock climbing) as well as hill-walking (6%), but many had experience of running (61%) and golf (33%).

## Scenarios

We developed 24 vignettes describing a hypothetical person performing a one-off sporting activity. For example,

Steve is a ski tourer. He is a very competent and focused athlete and he has carefully developed his fitness and skills to engage in the sport responsibly. He has a lot of experience as a skier and mountaineer. He plans to ski a famous mountain – which lasts on average about 8 hours. Steve is told by the local authorities that over the last few years there have been some fatalities on this ski descent at a rate of roughly 1 in 160,000 skiers (~ 6 in 1 Million). Steve is 35 years old and has a partner but no dependants.

Previous research has suggested that people tend to judge an activity less risky if they are asked how risky the activity is for them than if they are asked how risky it is for a third person (Weinstein 1980; Weinstein 1989). However, there are some doubts whether this is the case for some adventure sports activities, such as rock climbing (Martha, Sanchez, and Gomà-i-Freixanet 2009). Further, Lerner et al. (2013) and Lerner, Streicher, and Raue (2018) show that this effect holds only for comparisons with an abstract third person e.g. 'a person', and not for specific third persons (even those identified only by adding a name, like we do above). We ask for third person assessments primarily because in Survey 2 we are interested in whether standard risk results involving expertise apply in the domain of adventure sports. Expertise in those surveys always refers to a characteristic of the risk *perceiver*, not to the characteristic of the hazard. Here a first person perspective would confound the two: a person who has never skied before assesses the risk for a person who has never skied before, while the expert skier assesses the risk for an expert. The need to keep these distinct does not naturally arise in most traditional assessment areas e.g. nuclear energy, medical conditions: because the perceiver's expertise has no bearing on the outcome, they assess the same event. But here, a third person perspective is necessary to maintain the same condition.

Different parts of the vignette description above were varied to test the effect of different factors on risk perceptions. We varied six factors: the type of sporting activity, the gender of the person doing the sporting activity, whether they had dependants, whether the activity was done for charity, whether the person was trained and competent to carry out the activity, whether a guide was used, and the fatality risk associated with the activity. In all cases, changes to the description were limited to only those factors being varied, with all other parts of the description kept the same. We reproduce one such variant here in full, involving a change of the sporting activity:

Ryan is a runner. He is a very competent and focused athlete and he has carefully developed his fitness and skills over many years to engage in the sport responsibly. He has a lot of experience as a runner. He plans to compete in a long distance road running race around Scotland – which lasts on average about 8 hours. Ryan is informed by the course organisers that over the last few years there have been some fatalities during this race at a rate of roughly 1 in 160,000 runners (~ 6 in a million). Ryan is 35 years old and has a partner but no dependants.

Other variants typically require smaller changes. All vignettes are provided in [Supplementary Material](#), with changes summarised here for ease of reference. To assess gender effects we changed the name of the person e.g. from 'Ryan' to 'Rebecca', as well as gender pronouns from 'he' to 'she'. Dependant effects were assessed by changing the final sentence from 'Ryan is 35 years old and has a partner but no dependants.' to 'Ryan is 35 years old and has a partner and two young children'. A charity variant included an additional sentence: 'Recently his mother was diagnosed with cancer and so he decides to ski a famous mountain to raise funds for the charity that cares for his mother'. Competence was varied by changing 'Steve is a ski tourer. He has a lot of experience as a skier and mountaineer' in two ways – both to 'Steve has recently learned to ski tour. He is fairly new to the sport but is very excited to engage in the activity more intensively', but one also including the additional sentence 'Because of his lack of experience, he decides to hire a professional mountain guide to ski a famous mountain', the other not. Competence thus has three variants (competent, not competent with no guide, not competent with guide). A variant with increased fatality risk changed the phrase '...a rate of roughly 1 in 160,000 skiers (~ 6 in 1 Million)' to '...a rate of roughly 1 in 1600 skiers (~ 600 in 1 Million)'.

### **Design and procedure**

We did not have the resources to conduct a full factorial experiment, which would have involved  $6 \text{ (sports)} \times 2 \text{ (gender)} \times 2 \text{ (dependants)} \times 2 \text{ (charity)} \times 3 \text{ (competence)} \times 2 \text{ (fatality rate)} = 288$  different vignettes. We therefore selected a subset of 24 vignettes that allowed us to address our main research objectives: to obtain a broad overview of perceptions of adventure sports, and to compare selected risk perceptions between experts and laypeople. For ease of description we break these vignettes into five subsets:

**Vignette subset A** independently varied the type of sport (six levels) and the gender of the sports participant (two levels), with all other descriptors fixed at baseline conditions (no dependants, not for charity, no guide, high competence, low fatality rate), giving 12 vignettes in total.

**Vignette subset B** restricted the type of sport to one adventure sport (ski-touring) and one non-adventure sport (running). For these two sports, we varied the gender of the sports participant and whether they had dependants or not, with all other descriptors at their baselines. This gives  $2 \times 2 \times 2 = 8$  vignettes in total, but note that vignettes for the 'no dependants' condition are already included in subset A, and thus data collection is required only for the 4 new vignettes.

**Vignette subsets C, D, E** restricted the type of sport to ski-touring and varied the gender of the sports participant and, respectively, each of the remaining conditions (subset C=charity, subset D=competence, subset E=fatality rate), with all other descriptors held at their baselines. This gives  $2 \times 2 = 4$  (subset C),  $2 \times 3 = 6$  (subset D), and  $2 \times 2 = 4$  (subset E) vignettes respectively, but again vignettes involving the baseline conditions (no charity, competence, and a fatality 1:160,000) are already included in subset A, and thus data collection is only required for 2 (C), 4 (D), and 2 (E) = 8 vignettes.

Participants accessed the online survey via the *Prolific* platform at a time and using a device of their choosing. We used a *between-subject* design in which each respondent saw only one vignette, with a randomization mechanism used to assign participants to vignettes. Upon reaching the online survey participants were provided with general information about the study and indicated their informed content. They were then shown background information about the general risk of a fatal accident of *any kind* each day in the UK, which is roughly 1 in 1 Million (Blastland and Spiegelhalter 2013; ONS 2012, table 5.19). This information was given to provide all survey participants with a common anchor and to make the role of the fatality risk salient in their assessment. Following this, they were taken to a new page showing the vignette and asking them to 'carefully read the following scenario and answer the questions below'. After

seeing the vignette respondents were asked 'how dangerous do you think it is for Ryan to engage in this activity?' and 'how reckless do you think Ryan is for engaging in this activity?', using a nine point Likert-scale ranging from 'not at all dangerous/reckless' to 'extremely dangerous/reckless'. Each assessment was followed up by a five point Likert scale to assess confidence in their judgement ('not at all confident' to 'extremely confident'). All vignettes, datasets, and code reproducing our results are available at <https://github.com/iandurbach/gratuitous-risk-taking>.

### Statistical analysis

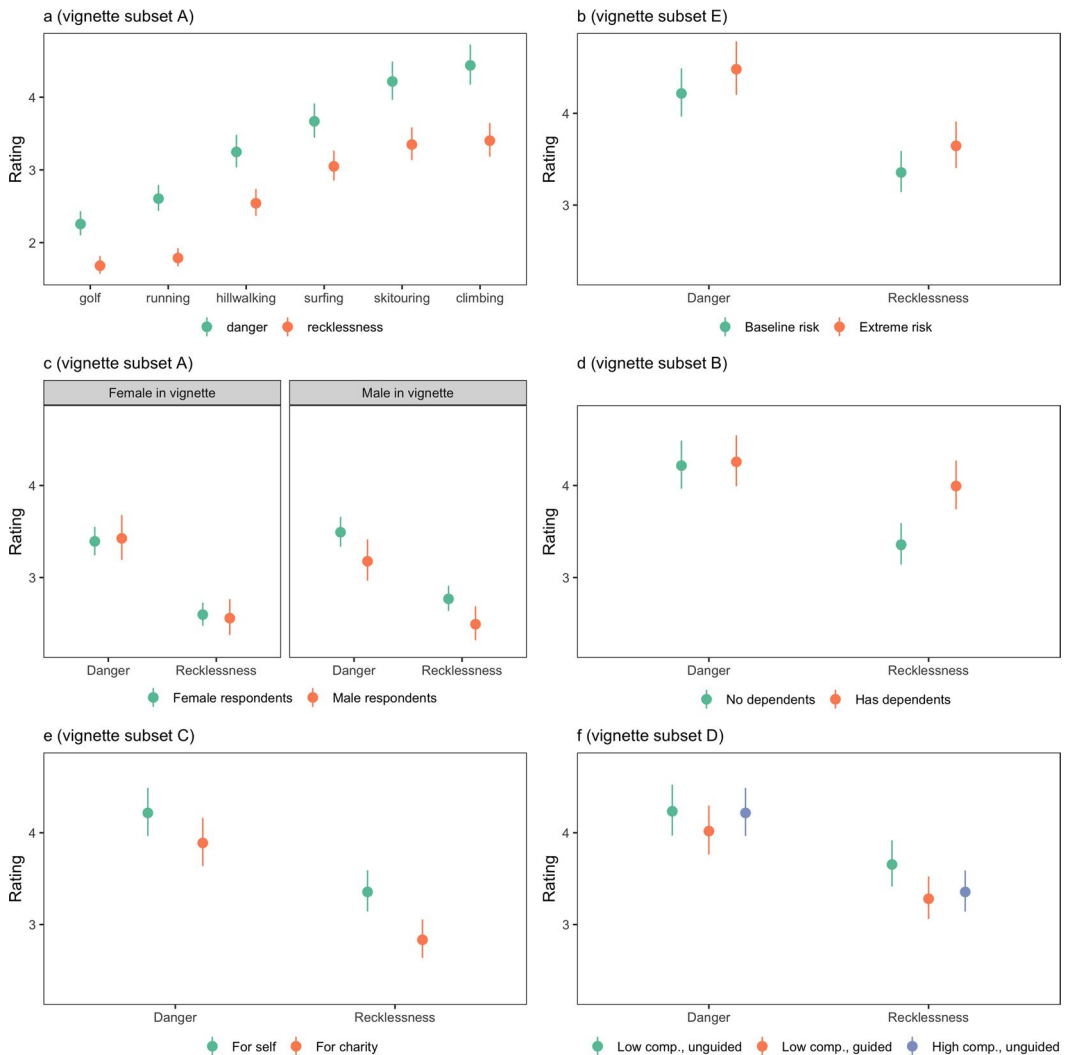
Data were analysed using generalized linear models (GLMs) implemented in R version 4.1.2 (R Core Team 2021). Danger and recklessness responses were modelled as Poisson random variables, which are typically used to model counts but which we found captured observed patterns in these responses (discrete valued and strongly skewed towards lower ratings) well. As Poisson random variables can take on any non-negative integer values we converted the original 1-9 rating scale to a 0-8 one for the purposes of modelling, but report results transformed back to the original scale. Residual checking suggested that a choice of Poisson GLM was reasonable, with residuals symmetric and approximately normal. As is usual for Poisson GLMs, the mean response was related to a linear combination of predictors, in this case indicators for the presence of one or more vignette scenario (sport type; presence of dependants, charity, low competence, guiding, extreme risk), through a log link function. Following model fitting, the Tukey method was used to adjust for multiple comparisons in subsequent post hoc tests. We assessed the overall significance of variables with more than two levels using a likelihood ratio test of models with and without that variable, reporting the associated  $\chi^2$  statistic. Marginal model means reported in the text were obtained by back-transformation of values from the linear scale. Confidence ratings were heavily skewed towards high confidence, with 90% and 91% of danger and recklessness judgements rated at least moderately confident. As a sensitivity analysis we repeated the analyses reported here removing any judgements made with less than moderate confidence, since these may indicate a lack of understanding. No material differences in any results were observed.

### Results

Adventure sports (rock climbing, ski-touring, surfing) were regarded as more dangerous and reckless to engage in than non-adventure sports (golf and running), even when fatality rates were held fixed, with hill-walking occupying an intermediate position (Danger  $\chi^2 = 84.3$ ,  $p < .001$ , Cohen's  $d = 0.99$ ; Recklessness  $\chi^2 = 59.4$ ,  $p < .001$ , Cohen's  $d = 0.82$ ; Figure 1a). Golf was judged least dangerous, followed by running, then hillwalking and surfing (these judged equally dangerous,  $z = 2.5$ ,  $p = .11$ ), and finally ski-touring and rock climbing as equally most dangerous ( $z > 1.1$ ,  $p < 0.87$ ; all other pairwise differences  $z > 3.1$ ,  $p < .027$ ). Mean recklessness ratings separated sports into three 'tiers': golf and running ( $z = 1.2$ ,  $p = 0.85$ ), hillwalking, and the three adventure sports ( $z < 2.2$ ,  $p > .22$ ; all other pairwise differences  $z > 3.6$ ,  $p < .005$ ). We found no evidence that personal experience of a sport affected how dangerous or reckless it was judged to be (danger: likelihood ratio test  $\chi^2_1 = 0.32$ ,  $p = 0.57$ ; recklessness:  $\chi^2_1 < 0.01$ ,  $p = .97$ ), nor did we find an interaction between personal experience and the type of sport involved (danger:  $\chi^2_6 = 2.48$ ,  $p = .87$ ; recklessness:  $\chi^2_6 = 4.92$ ,  $p = .55$ ).

Increasing fatality rates 100-fold increased mean perceived danger from 4.22 (95% CI 3.97–4.49) to 4.48 (95% CI 4.20–4.78), and mean perceived recklessness from 3.36 (95% CI 3.14–3.59) to 3.65 (95% CI 3.40–3.91; Figure 1b). Increases in danger were not statistically significant ( $z = 1.33$ ,  $p = .18$ ), while those for recklessness were at most very marginally so ( $z = 1.69$ ,  $p = .09$ ).





**Figure 1.** Differences in mean danger and recklessness evaluations across sports and vignette conditions, with vertical lines denoting 95% confidence intervals. Figure panels indicate our main findings that (a) adventure sports were judged more reckless than non-adventure sports, although background risks were held constant; (b) increasing fatality rates 100 × had at most modest effects on ratings; (c) male sports participants are judged in less danger and less reckless by male than female respondents; (d) sports participants were judged as more reckless when the sport participant had dependants; (e) sports participants were judged less reckless when doing an activity for charity; (f) experience and drawing on expertise of a professional guide had no significant effect on danger and recklessness judgements.

Considering that we increased fatality rates by two orders of magnitude, changes in response variables were modest.

Male and female sports participants in our vignettes were judged on average similarly reckless (male 95% CI 2.51–2.75; female 95% CI 2.46–2.70,  $z = -0.56$ ,  $p = .58$ ) and in danger (male 95% CI 3.19–3.47; female 95% CI 3.27–3.56,  $z = 0.77$ ,  $p = .44$ ). Male sports participants were rated less reckless by male respondents than female respondents (male 95% CI 2.32–2.69; female 95% CI 2.64–2.91;  $z = 2.28$ ,  $p = .02$ ), and also in less danger (male 95% CI 2.97–3.41; female 95% CI 3.33–3.66;  $z = 2.17$ ,  $p = .03$ ; Figure 1c, right-hand panel). No significant differences existed for female sports participants (Danger  $z = 0.22$ ,  $p = .82$ , Recklessness  $z = 0.33$ ,  $p = .74$ ;



Figure 1c, left-hand panel). No significant interactions involving sport occurred, and the results reported here are for responses pooled over the two sports used (skitouring, running).

Sports participants were judged more reckless if they had dependants (with dependants 95% CI 3.74–4.27; without dependants 95% CI 3.14–3.59;  $z = 3.61$ ,  $p < .001$ , Cohen's  $d = 0.35$ ), but with no coincident increase in danger ( $z = 0.21$ ,  $p = .83$ , Figure 1d). Engaging in a sport for charitable purposes decreased recklessness judgements (for charity 95% CI 2.64–3.05; for self 95% CI 3.14–3.59;  $z = 3.31$ ,  $p < .001$ , Cohen's  $d = 0.32$ ), but evidence for a similar decrease in danger judgements was weak (for charity 95% CI 3.64–4.16; for self 95% CI 3.97–4.49;  $z = 1.73$ ,  $p = .08$ ; Figure 1e). Being highly competent, or otherwise being accompanied by a guide, had no significant effect on danger or recklessness assessments (Danger  $\chi^2_2 = 1.52$ ,  $p = .47$ ; Recklessness  $\chi^2_2 = 5.20$ ,  $p = .07$ ; Figure 1e).

## Survey 2

### Participants

Respondents were recruited by adding this survey as an opt-in survey at the end of a large-scale user-experience survey for the *Scottish Avalanche Information Service* (SAIS). Participants for the large-scale survey were recruited through the SAIS website for a six week period in March 2021 and through paid advertisements on skiing related websites such as *UKclimbing.com* or facebook groups such as *British Backcountry*. A total of 1109 respondents took part in the larger survey, 362 (33%) of whom completed our survey. The lower number is partly due to non-skiers responding to the larger survey.

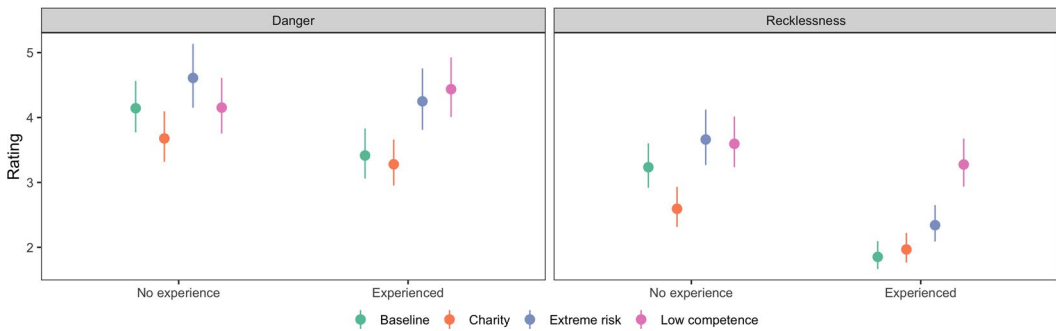
The respondents' mean age, based on the mid-points of age categories, was 45.6, with substantial variation (5% 18–24, 18% 25–34, 25% 35–44, 24% 45–54, 20% 55–64, 7% 65+). Respondents had on average 13.9 years skiing experience, with 83% of respondents having more than 5 years experience (5% 1–2y, 12% 3–5y, 17% 6–10y, 23% 11–20y, 42% 20+y). In contrast to Survey 1, most respondents in Survey 2 identified as male (64 = 18% female, 290 = 80% male, 8 = 2% other).

### Design and procedure

Recruiting survey participants with extensive experience of adventure sports is far harder than recruiting laypeople, and using all 24 vignettes from Survey 1 while maintaining the same statistical power was not feasible. Based on initial expectations of 1000 respondents in the large-scale survey and a 30% response rate for our additional survey, we restricted ourselves to four vignettes, on the basis that this would provide on average 75 responses per vignette and thus maintain similar statistical power to Survey 1. All four vignettes use skitouring with a male participant. We use (a) a vignette with all descriptors fixed at their baseline conditions (no dependants, not for charity, no guide, high competence, low fatality rate); (b) a vignette in which the fatality rate is 1:1600; (c) a vignette in which the activity is done for charity, and (d) a vignette in which the person doing the activity has low competence and is without a guide. In vignettes b-d all other descriptors are fixed at their baseline conditions. Apart from the initial recruitment we used exactly the same online survey as in Survey 1. Vignettes were therefore worded exactly the same as in Survey 1 and participants saw these and all other survey elements (introduction, consent, etc) as they appeared in Survey 1.

### Statistical analysis

We compared responses to vignettes a-d above to responses obtained for the same vignettes in Survey 1. Here we are interested in the comparisons between experienced and inexperienced



**Figure 2.** Mean danger and recklessness evaluations by experienced skiers across different vignette descriptions, with equivalent responses for non-skiers (extracted from Survey 1) shown for comparison. Vertical lines denoting 95% confidence intervals around the mean response. Experienced skiers viewed the activity as less reckless, were more sensitive to fatality rate and participant competence, and less sensitive to whether the event was done for charity.

respondents, and so we removed any respondents from Survey 1 that indicated previous ski-touring experience (10, 12, 7, and 24 respondents for vignettes a-d respectively). Note that as we only use those Survey 1 vignettes involving male participants (to ensure comparability with Survey 2), mean responses for non-skiers can be different from those observed in Survey 1, and in particular confidence intervals around those mean responses are wider than those observed in Survey 1, where female- and male-based vignettes were used.

In other respects analysis was done in the same way as for Survey 1. We fitted a Poisson GLM with danger or recklessness ratings as the response variable and vignette condition (with four levels: baseline, higher-fatality, for charity, low competence), skiing experience (experienced, no experience), and their interaction as independent variables. To account for differences in the gender distribution of respondents between Survey 1 (mostly female) and Survey 2 (mostly male), and to avoid potentially confounding skiing experience with gender, participant gender and its interaction with vignette condition were included as additional independent variables. Post hoc testing was performed as for Survey 1.

## Results

Our main results (Figure 2) are that:

1. experienced skiers gave lower overall recklessness ratings than non-skiers;
2. experienced skiers were more sensitive than non-skiers to variations in the fatality rate of the activity and the competence level of the participant;
3. experienced skiers were less sensitive to whether the event was done for external benefit such as a charity;
4. experienced skiers recklessness judgements were more sensitive to changes in activity descriptions than danger judgements.

More specifically, experienced skiers gave lower danger and significantly lower recklessness ratings in the baseline scenario than those without any skiing experience (Danger: experienced mean 3.41, 95% CI 3.06–3.83; no experience mean 4.14, 95% CI 3.77–4.56;  $z = -2.33$ ,  $p = .13$ ;  $d = 0.29$ ; Recklessness: experienced mean 1.85, 95% CI 1.66–2.09; no experience mean 3.23, 95% CI 2.92–3.60;  $z = -6.03$ ,  $p < .001$ ; Cohen's  $d = 0.80$ ).

Experienced skiers rated the higher-fatality scenario more dangerous and reckless than the baseline scenario (Danger: higher-fatality mean 4.25, 95% CI 3.81–4.76; baseline mean 3.41, 95%

CI 3.06–3.83;  $z = -2.72$ ,  $p = .04$ ; Cohen's  $d = 0.33$ ; Recklessness: higher-fatality mean 2.34, 95% CI 2.09–2.65; baseline mean 1.85, 95% CI 1.66–2.09;  $z = -2.811$ ,  $p = .03$ ; Cohen's  $d = 0.39$ ). There was no evidence of significant differences for either danger or recklessness ratings provided by non-skiers, although both changes were also in the expected direction (Danger: higher-fatality mean 4.61, 95% CI 4.15–5.13; baseline mean 4.14, 95% CI 3.77–4.56;  $z = -1.47$ ,  $p = .65$ ; Recklessness: higher-fatality mean 3.66, 95% CI 3.27–4.12; baseline mean 3.23, 95% CI 2.92–3.60;  $z = -1.57$ ,  $p = .58$ ).

Skiers' judgements were unaffected by whether the activity was performed for charity or not (Danger: for charity mean 3.28, 95% CI 2.95–3.66; baseline mean 3.41, 95% CI 3.06–3.83;  $z = -0.51$ ,  $p > .99$ ; Recklessness: for charity mean 1.97, 95% CI 1.77–2.22; baseline mean 1.85, 95% CI 1.66–2.09;  $z = -0.72$ ,  $p = .99$ ). In contrast, non-skiers judged the activity less dangerous and reckless if done for charity, although this difference was only statistically significant for recklessness (Danger: for charity mean 3.68, 95% CI 3.32–4.09; baseline mean 4.14, 95% CI 3.77–4.56;  $z = 1.65$ ,  $p = .52$ ; Recklessness: for charity mean 2.58, 95% CI 2.26–2.95; baseline mean 3.23, 95% CI 2.92–3.60;  $z = 2.74$ ,  $p = .04$ ; Cohen's  $d = 0.28$ ).

Experienced skiers rated an activity substantially more dangerous and reckless if undertaken by someone with low competence (Danger: low competence mean 4.44, 95% CI 4.01–4.93; baseline mean 3.41, 95% CI 3.06–3.83;  $z = -3.39$ ,  $p = .005$ ; Cohen's  $d = 0.39$ ; Recklessness: low competence mean 3.28, 95% CI 2.94–3.67; baseline mean 1.85, 95% CI 1.66–2.09;  $z = -6.82$ ,  $p < .001$ ; Cohen's  $d = 0.82$ ). In contrast, non-skiers' danger and recklessness judgements were essentially unaffected by the competence of the participant (Danger: low competence mean 4.15, 95% CI 3.75–4.61; baseline mean 4.14, 95% CI 3.77–4.56;  $z = -0.03$ ,  $p > .99$ ; Recklessness: low competence mean 3.60, 95% CI 3.23–4.01; baseline mean 3.23, 95% CI 2.92–3.60;  $z = -1.39$ ,  $p = .71$ ).

## Discussion

Our results support existing findings about differences in risk perception between laypeople and experts in other fields. Expert risk judgements show sensitivity to variations of objective features, such as competence and fatality rating, and they are not influenced by extrinsic benefits (e.g. whether the activity is done for charity). In contrast, laypeople show little sensitivity to variations in objective factors (competence, professionalism or fatality)—a finding supported by the observation (Survey 1) that laypeople's danger judgements vary substantially across different sporting activities despite a fixed case-specific fatality rate. Further, laypeople's danger judgements are more easily influenced by features that are not directly connected to objective risk factors, such as extrinsic benefits (done for charity).

One possible explanation for the different effect of charity on the two groups' judgements can be obtained by interpreting intuitive recklessness judgements in terms of expected *benefits*. Laypeople regard adventure sports as somewhat 'gratuitous', at least when compared to other sports. However, this activity becomes more valuable, and thus overall less reckless, when done for charity. On the other hand, for adventure sports participants the expected benefits tend to be more narrowly composed and unaffected by extrinsic benefits since what primarily counts for this group is the *personal* experience of the activity and not its value for others.

On the natural assumption that active expert skiers with years of experience have a more positive affective relation to the activity than laypeople who have not engaged in that activity, we would expect lower danger and recklessness ratings for the expert group. This is what we found (Figure 2) and these findings cohere well with prior research on the role of affect in risk perception in other context (Finucane, Alhakami, et al. 2000).

Danger judgements were consistently higher than recklessness judgements in both groups. Although danger and recklessness scales are not directly comparable, there were no scenarios in which experts provided high danger and low recklessness judgements, which is something one might expect on a more traditional thrill-seeking picture of adventure sports participants. Indeed, laypeople produced more judgements in which recklessness exceeded danger than experts, although for both groups these were rare (14% of laypeople, 6% of experts).

Experts rated incompetent sports participants as significantly more reckless than competent participants subjected to a 100-fold greater risk of fatality. This finding highlights an important aspect of expert risk perception in the context of adventure sports that we alluded to in the introduction: they value being *responsible* risk takers whose decisions are grounded in competence—a status that requires training and experience. These observations should further support the already emerging picture of adventure sports participants, at least in the context of ski touring, as rational and sensitive to risk relevant features rather than somehow pathological in their risk perception.

We also note an interesting ‘no-finding’ in Survey 1: we did not identify a straightforward gender bias in danger or recklessness judgement, even when restricting to adventure sports (despite the reasonably high power of our survey). This is in line with recent studies critical of gender effects in risk judgements (Olofsson and Rashid 2011). It is worth noting, however, that our study investigated only *ex ante* danger and recklessness judgements and not *ex post*. Investigating whether there are any gender biases once the outcome of the given sports activity, in particular when a negative outcome, is specified, remains an open question. A further limitation of this result is that we did not investigate the race of the respondents and so our findings do not directly speak against a possible ‘white male effect.’ However, given the third person design we could identify a more complex gender bias: male respondents give on average lower ratings (both danger and recklessness) than female respondents when they judge male sports participants. Notably, at least with respect to recklessness judgements, this ‘male effect’ is partly driven by a corresponding ‘female effect’: female respondents seem to rate male sports participants as more reckless compared to female sports participants, however, this effect was weak ( $z = 1.8$ ,  $p = 0.07$ ; see Figure 1c). In summary, male and female respondents broadly agree in their assessment of female sports participants, yet they disagree in their judgements about male sport participants. Future research might probe these findings and further investigate an intra-gender vs inter-gender divide in danger or recklessness judgements.

Given the limited pool of expert respondents, we could not recreate all conditions of Survey 1. In particular, given our ‘no-finding’ finding, we did not test for gender effects in the expert group. Also, while dependants had a significant effect on laypeople’s recklessness judgements, we do not know whether this condition affects experts or whether it is a condition akin to charity in expert judgements. Nonetheless, it is worth noting that throughout Survey 1 and 2, recklessness judgements were more sensitive to variations, and produced larger effect sizes, than danger judgements. As we suggested earlier, recklessness is a type of risk judgement that involves an *evaluative* dimension with distinct *moral* overtones. So, for example in a legal context, a reckless person is someone who ‘knowingly takes a substantial and unjustified risk’ (American Law Institute 1985, 2.02), and according to the OED it is someone ‘irresponsible’ and ‘indifferent to the consequences of their action’. The connection between the acceptability of a risk and its moral worth has been investigated previously (Sjöberg and Winroth 1986). On the assumption that recklessness is inversely related to moral worth, our results suggest that future studies investigating differences of expert and laypeople’s risk judgements may want to ensure separating clearly these two question formats. While they are strongly correlated, the moral evaluative component of a risk judgements is more sensitive (and potentially more strongly so) to underlying contextual features than the corresponding danger judgements.

## Note

1. The National Living Wage in the UK at the time of the surveys was £7.83-8.21. Prolific requires a minimum average pay of £5 per hour.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Funding

Arts and Humanities Research Council; Royal Society of Edinburgh.

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