Risk appraisal and decision making in front of avalanche risk: A pilot study with backcountry skiers

Andres Chamarro\textsuperscript{1}*, Gloria Martí\textsuperscript{2, 3}, Tatiana Rovira\textsuperscript{1}, Francesc Carola\textsuperscript{2}, and Jordi Fernández-Castro\textsuperscript{1}

\textsuperscript{1}Autonomous University of Barcelona. Barcelona. Spain
\textsuperscript{2}Snow and Avalanche Awareness Association in Catalonia (ACNA). Lleida. Spain
\textsuperscript{3}Geological Institute of Catalonia (IGC). Barcelona. Spain

ABSTRACT: Studies and knowledge of human factor in avalanche fatalities are scarce or even null in the study area. Consequently, research into how people evaluate and react in front of avalanche risk is still necessary. The present study examined how the information provided by avalanche bulletin, terrain exposure and carrying safety gear is combined by backcountry skiers to elaborate risk perception and ulterior decision making. Seventy four backcountry skiers completed the designed survey to monitor this study during weekend routes or avalanche training courses. Surveys included simulated scenarios that represented the kinds of information that participant may be confronted when backcountry skiing. Results show how risk judgments and decision to not continue are affected by information relative to terrain exposure, avalanche danger rating and carrying safety gear. For risk judgment, by one side backcountry skiers combine information relative to terrain exposure and avalanche danger rating, and avalanche danger rating and carrying safety gear, by the other side. When deciding to continue, the pattern is quite similar, but an interaction between the three variables appears, indicating that skiers decide to not continue especially when terrain is challenging, rating 3 avalanche danger and they carry safety gear. Is concluded that skiers can use deliberative processes appraise risk and take decisions. Also, the study validates the information about terrain exposure, avalanche bulletin, and carrying safety gear, usually provided in avalanche education programs.

KEYWORDS: Avalanche Education; Risk Appraisal; Decision-Making.

1 INTRODUCTION

Avalanche fatalities occur every Winter Season in Catalan Pyrenees with a media of 1-2 dead people per season. The 80% of all avalanches leading accidents were triggered by the injured people itself or others involved (www.igc.cat). Courses in avalanche education attained by the Snow and Avalanche Awareness Association in Catalonia (ACNA) have improved avalanche knowledge for practitioners, but there is no evidence of their effect over skier’s behavior. Even so, studies and knowledge of human factor in this area are scarce. Consequently, research into how people evaluate and react in front of avalanche risks is still necessary.

Previous research has pointed out that exposure to avalanche terrain is an important parameter for winter route finding decisions in the backcountry (Statham et al., 2004) and has been considered a relevant information to be incorporated to avalanche bulletins in some areas of the Pyrenees (Bacardit et al., 2011). Also, information provided by avalanche bulletin is necessary if we expect that recreationists adopt protective measures (Martí, 2009). Additionally, is accepted that the combination of Transceiver-Probe-Shovel must be carried as basic safety gear for rescue when a person is buried by an avalanche. Taken together, all this elements seem to be some the basic components of avalanche education programs (Furman et al., 2010). These safety measures may play a preventive role if they allow adopting safe decision making in front of possible dangers.

The present study examined how the information provided by avalanche bulletin, terrain exposure and carrying rescue equipment is combined by skiers to elaborate risk perception and ulterior decision making. These judgments should be a necessary condition for protecting themselves during the practice of backcountry skiing.
2 BACKGROUND

There is a considerable amount of literature about the decision making process in backcountry skiing and another outdoor winter activities. It is accepted that decision making abilities can be learned and a large amount of information is provided in USA, Canada and European websites. However, it seems that there is not an identified algorithm for decision-making, in contrast with the numerous courses that train recreationists in avalanche skills training.

This is understandable if we consider that when we analyze skiers’ behavior and decision making, the main identified strategies are heuristics, which are considered as traps for effective decision making (McCammon, 2004). It would seem that recreational skiers can’t perform reasonable judgments and take appropriate decisions, except identify and avoid heuristics, because they may take decisions under pressure and with unavailable complete information. But what decisions could be used to substitute heuristics? We think that in a world where skiers dispose of precise and available information about terrain exposure and avalanche danger when planning a route, they should be able to use this information in an effective way. Recent advances in cognition science suggest that people can use dual-processes for decision making. The first should be based on intuitive and automated “rules of thumb”, while the second could be more rationale and deliberate (Kahneman, 2011). However, there is no research about how these deliberate judgments can be elaborated by backcountry skiers and how they can be related to ulterior decisions, even if there is a growing interest in identifying algorithms for assessing avalanche danger that could be used by novice users (McCammon and Hägeli, 2007).

According to previous research with hikers (Chamarro et al., 2010), recreationists can integrate available information into a new complex risk judgment. For this reason, the purpose of this study was to identify what kind of combination exists among these different appraisals in order to generate a judgment and decision based on the ultimate level of perceived risk in backcountry skiers.

However, if these judgments and decisions are identified then they could be used as basic algorithms for training modules in decision making in backcountry avalanche education courses.

3 METHOD

In the frame of collaboration between the Autonomous University of Barcelona and ACNA, some enquiries have been done during the 2012-13 winter to deep into this issue.

3.1 Participants

Seventy four backcountry skiers participated in this study. Fifty two were male (70.3%). The mean age was 46.36 years, ranging between 21 and 68. The mean experience was 20.13 years, ranging between 2 and 20 years.

3.2 Materials

To conduct this study, the theoretical and methodological framework of the Functional Theory of Cognition (Anderson, 1996) was adopted, which strives to determine how people use the information available to them to take decisions and form judgments. According to this methodology, simulated scenarios were used which represented the kinds of information that backcountry skiers may use when planning and conducting a route. Eighteen scenarios were designed, the outcome of combining one of the levels for each variable: avalanche danger ratings 1-2, 3, 4-5 of the European Avalanche Danger Scales; simple, challenging and complex terrains from the Avalanche Terrain Exposure Scale (ATES); carrying vs no carrying full safety gear (RVA-shovel-probe). An example of simulated scenario could be: “You are doing a ski tour with your habitual teammates. 1-2 avalanche danger rating. Terrain is challenging. You are carrying your security equipment (RVA-shovel-probe)”. For each of the simulated scenarios, the perception of risk and the subsequent decision were recorded. Finally, athletes were asked to report age, gender, and years of experience.

3.3 Design

According to the methodology of simulated scenarios, for each variable being studied three different levels were considered; giving rise to a within-subject experimental design of 3x3x2 in which the scenarios were presented randomly. The use of a within-subject design ensures that all the participants experience all the conditions; which enable the control of possible individual differences.
3.4 Procedure

The participants rated the scenarios individually. The procedure had two phases. In the first, the participants familiarized themselves with the task at hand by responding to 6 scenarios, two with the most extreme levels to avoid the ceiling and floor effect in the remaining scenarios. The data obtained in these first phase were not used in the subsequent analyses. In the second experimental phase, all 18 scenarios were presented randomly for each participant. The questionnaires were administered by group leaders in the huts during backcountry routes or by ACNA avalanche educators in avalanche training courses during the 2012-13 winter season.

3.5 Data analysis

We conducted two analysis of variance (ANOVA) for repeated measures with terrain complexity (simple, challenging and complex), risk avalanche (grades 1-2, 3, 4-5) and safety gear (carrying vs. not carrying) as the factors.

3.6. Results

The perceived risk level ranged between 2.47 and 10.5 points. The analysis of variance indicated that the main effects of the three variables included in the scenarios were significant. Risk perception was related to higher levels of terrain complexity \[ F(2,72) = 99.7, p < .001 \], an increment in avalanche danger \[ F(2,72) = 368.5, p < .001 \], and not carrying safety gear \[ F(1,73) = 63.35, p < .001 \].

Regarding the relationship among the different independent variables, the interaction between terrain exposure and avalanche danger was significant \[ F(4,70) = 3.67, p < .005 \], as the interaction between the avalanche danger and carrying safety gear was \[ F(2,72) = 10.2, p < .001 \]. In contrast, the interaction between terrain exposure and carrying safety gear was not significant \[ F(2,72) = 2.1, ns \], nor the second-order interaction \[ F(4,70) = 1.26, ns \].

Figure 2 shows risk perception according to avalanche danger level and carrying safety gear. At all levels of risk avalanche, when not carrying safety gear (green line), the higher the levels of perceived risk; but the increase in the level of perceived risk observed between moderate and high levels was lower in the case of not carrying safety gear (green line). However, when carrying safety gear (blue line) and avalanche danger is low the perceived risk is minimal.

Decision level ranged between 1.8 and 10.3 points. The analysis of variance indicated that the main effects of the three variables included in the scenarios were significant. Decision was related to higher levels of terrain complexity \[ F(2,72) = 98.3, p < .001 \], an increment in avalanche danger \[ F(2,72) =
404.3, \( p < .001 \), and not carrying safety gear \( [F(1,73) = 74.27, p < .001] \).

Regarding the relationship among the different independent variables, the interaction between terrain exposure and avalanche danger was significant \( [F(4,70) = 4.84, p < .005] \), as was the interaction between risk avalanche and carrying safety gear \( [F(2,72) = 17.9, p < .001] \), and the second-order interaction \( [F(4,70) = 5.3, p < .001] \). In contrast, the interaction between terrain exposure and carrying safety gear was not significant \( [F(2,72) = 1.8, ns] \).

Figure 3 shows decision to continue according to terrain complexity and risk avalanche. When terrain changes from simple to challenging decision to no continue becomes higher, especially when avalanche danger is 4-5 rating. Figure 4 shows how decision to continue changes according to avalanche risk and carrying safety gear. At all levels of avalanche risk the higher the decision to no continue is superior when not carrying safety gear (green line); but the increase in the level of decision observed between moderate and high levels was lower in the case of not carrying safety gear (green line). However, when carrying safety gear (blue line) and avalanche danger is low the decision is to continue.

Figure 4. Decision to continue as a function of avalanche risk and carrying safety gear

Figure 5. Decision to continue as a function of terrain complexity and avalanche risk when carrying safety gear

Figure 5 and 6 show how decision to continue changes according to terrain complexity and avalanche danger. When terrain changes from simple to challenging decision to no continue becomes higher, especially when avalanche danger is 4-5 level and for backcountry skiers carrying safety gear.
Figure 6. Decision to continue as a function of terrain complexity and avalanche danger when not carrying safety gear

4 DISCUSSION

The purpose of this study was to ascertain how terrain exposure, avalanche risk and carrying safety gear are combined in order to establish a risk judgment and ulterior decision to (not) continue the route in backcountry skiers. One of the first results to highlight is that all three factors proved to be relevant when studying risk perception and decision making. From our point of view these result show that information provided by avalanche bulletin and avalanche education programs are becoming effective. Skiers use this information when planning and executing a backcountry route.

In our study, the significance of the interactions indicates that not all information is used at the same time when risk judging. Skiers may combine terrain exposure and avalanche risk; and avalanche risk with carrying safety gear, but not terrain exposure with safety gear or all the three at the same time. These results suggest that even if all information is available, not all is considered as adding risk. It seems as if with two risk information sources it is sufficient, for perceiving risk. When decision making, our results are slightly different and suggest that in this case skiers may use all the three information sources, as second order interactions suggest, for adopting a decision. It seems that when situation is quite complex skiers may adopt new decisions avoiding prolonged risk exposure (i.e. changing the route). Also, when danger expressed by avalanche bulletin is low and skiers carry safety gear, they perceive minimal risk and clearly decide to continue the route. They might interpret the low severity of conditions as low probability of risk.

These results highlight how skiers may combine existing information into new judgments and make decisions. Completing the large amount of literature dedicated to heuristic processes in sport in general and backcountry skiing in particular (Furman et al., 2010; McCammon, 2004), our study demonstrate that athletes may also use deliberative processes.

Our study is the first attempt to systematically analyze deliberative process when decision making in backcountry skiing. Future studies could include identified components of existing rule-based decision tools (McCammon and Hägeli, 2007) for knowing how they are used for adopting decision making in backcountry skiers and winter recreationists.

From an applied point of view, this is a base for knowing what kind of decision making rules backcountry skiers can learn as an alternative to automatic heuristics. If avalanche training programs could show skiers how identify when they take decisions in an automatic or intuitive way, then they could substitute them by deliberative processes. Also, as a direct recommendation derived of our study, we should encourage the divulgation of terrain exposure categorizations, the use of available avalanche information provided by local authorities and training in the use of safety gear. So, the utility of avalanche education programs remains clear: they may be useful as the divulgation tool for novice users.

The contributions of this study should be understood in light of some limitations. Given that the sample was made up of expert backcountry skiers, these results would have to be replicated with novice users; given that expertise might influence the way they appraise and combine the information (Ericson et al., 1993).

4 ACKNOWLEDGEMENT

The authors want to thank the people who kindly filled the surveys. Without them the present study wouldn’t be impossible.

5 REFERENCES

Bacardit, M., Moner, I. and Gavaldà, J., 2011. Si la neu és el problema, la solució és en el terreny: Aplicació de l′Escala de Classificació del Terreny Allavós a la Val d′Aran [If the snow is the problem, the solution is terrain: Applying Avalanche Terrain Exposure Scale to Val D′Aran valley]. IV Jornades tècniques de neu i allaus. Vila, Spain.
Furman, N., Shooter, W. and Schumann, S. 2010. The roles of heuristics, avalanche forecast and risk propensity in the decision making of


