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Scott Schumann
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Nate Furman[a]; Wynn Shooter[b]; Scott Schumann[c]
[a] Department of Recreation and Outdoor Studies, Green Mountain College, Poultney, VT, USA [b] Department of Education, Monash University, Melbourne, Australia [c] Department of Parks, Recreation, and Tourism, University of Utah, Salt Lake City, UT, USA

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NATE FURMAN

Department of Recreation and Outdoor Studies
Green Mountain College
Poultney, VT, USA

WYNN SHOOTER

Department of Education
Monash University
Melbourne, Australia

SCOTT SCHUMANN

Department of Parks, Recreation, and Tourism
University of Utah
Salt Lake City, UT, USA

Backcountry winter recreation accidents and deaths due to avalanches have grown considerably in recent decades. To better understand how individuals make decisions in avalanche terrain, this study examined the decision-making factors identified by McCammon (2004) that are said to be complicit in avalanche accidents. This study also explored risk-taking propensity and avalanche forecast variables in decision making. Results indicate that five decision-making factors, risk-taking propensity, and avalanche forecast variables influence the decision to ski a slope. Implications for how individuals make decisions in risky leisure pursuits are discussed and implications for outdoor recreation, and avalanche education are considered.

Keywords avalanche education, decision making, heuristics, outdoor recreation, skiing

Backcountry winter recreation has increased in popularity in recent decades. Trends indicate that people are spending more leisure time backcountry skiing and snowboarding, hiking in snowshoes, and riding snowmobiles (Grímsdóttir & McClung, 2006; Haegeli, Haider, Longland, & Beardmore, 2009; Wheeler, 2008). From 1998 to 2005, the number of telemark[1] skiers has increased fourfold and continues to grow (Outdoor Industry Foundation, 2008). Although the reasons for this growth in winter recreation are not well

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Address correspondence to Nate Furman, Department of Recreation and Outdoor Studies, Green Mountain College, One Brennan Circle, Poultney, VT 05764. E-mail: furmann@greenmtn.edu
[1]Telemark skis are a type of ski commonly used to access backcountry terrain.

understood, the growth is consistent with a general increase in high-risk recreation participation (Olivier, 2006). The increase may be a result of the availability of better equipment, more convenient access to terrain, or a response to rising costs of skiing at ski resorts (Haegeli et al., 2009; Soles, 2005). This rise in winter backcountry use has mirrored the increase in avalanche-related fatalities (Page, Atkins, Shockley, & Yaron, 1999). From 1998–2008, there were 437 avalanche-related fatalities in the United States and Canada (American Avalanche Association, n.d.). Although it is unknown how many of these individuals were recreationists, Fredston, Fessler, and Tremper (1994) reported that 93% of avalanche fatalities from 1980–1993 were recreational backcountry users. From 1995–2005, there were more fatalities in the United States due to avalanches than to hurricanes and earthquakes combined (Utah Avalanche Center, n.d.).

Given the growth in avalanche fatalities, it is not surprising that the number of avalanche education programs has increased. The American Institute for Avalanche Research and Education (AIARE) reports that there were approximately 300 avalanche education courses in the United States in 2008 compared to about 100 in 1989 (B. Lazar, personal communication, August 25, 2009). Traditional avalanche education curriculum includes information about snowpack, weather systems, observation techniques, and terrain analysis. In recent years, avalanche educators have placed greater focus on how human factors contribute to avalanche accidents. Human factors include such hazards as overconfidence, haste, inexperience, and complacency (Schimelpfenig, 2003).

How to decrease the number of avalanche fatalities has eluded educators and researchers. One explanation for why avalanche-related deaths continue to increase, despite the growth of avalanche education programs, was offered by McCammon (2004). He suggested that recreational backcountry skiers fall victim to avalanche accidents by unconsciously relying on *heuristics*, which are "rule of thumbs" that aid decision making. Using heuristics enables decision makers to make decisions quickly and without undue burden to cognitive resources. However, McCammon suggested that employing common heuristics can be misleading when assessing the stability of snowpack and making decisions to ski in avalanche terrain. Using data from avalanche accident and incident reports, McCammon concluded that a set of six heuristic "traps" help explain why backcountry skier decisions can be flawed and, ultimately, are complicit in avalanche incidents. The literature on heuristic traps in decision making has since grown in the field of adventure recreation and outdoor education (Bauch, 2006; Ewert, Shellman, & Glenn, 2006; Stremba, 2005, 2009).

McCammon's hypothesis that heuristic-based decision-making factors influence decision making warrants a closer look. To address this question, this study explored the degree to which backcountry[2] skiers relied on McCammon's six heuristics when deciding to ski a potentially unstable, hazardous slope. This study also examined how the effects of information about forecasted avalanche conditions and risk-taking propensity might influence the decision to ski a slope. To that end, this article will review literature related to decision theory with a focus on Behavioral Decision Theory, the role of expertise, and decision complexity. Further, it will address heuristics, heuristic traps, and risk-taking propensity literature.

Literature Review

Decision Theory

Broadly speaking, there are three conceptual branches of decision theories: (a) classical, normative models, (b) models that focus on automated processes of decision making such

[2]The term "backcountry" refers to "mountainous terrain where avalanche hazard is not actively controlled by professional avalanche technicians before recreationists enter the area" (Haegeli et al., 2009).

as the role of affect, intuition, and heuristics, and (c) dual-process models, which explain decision-making based on some combination of the previous two models. First, classical models of decision making suggest that decisions are made from a purely rational, cognitive perspective (Beach & Lipshitz, 1993). These models resemble a mathematical equation whereby individuals thoughtfully examine potential outcomes of decisions, assign likelihood probabilities to those outcomes, and attempt to maximize goal attainment based on those projected outcomes (Baron, 2004; Edwards, 1961; Savage, 1954; von Neumann & Morgenstern, 1947). Baron (2004) cited Expected Utility Theory and Bayes's Theorem as examples of such normative models.

Second, models that account for the role of affect, intuition, and heuristics focus on how emotion or automaticity affects decisions. Although some research contends that affect is an unwanted bias in decision making (see Forgas, 1995, for a review), other research argues that affect aids decisions by focusing selective attention and delimiting the potential infinite number of decision cues (Damasio, 1994). Intuition has been defined as "affectively charged judgments that arise through rapid, nonconscious, and holistic associations" (Dane & Pratt, 2007, p. 3) and might aid complex decision making, particularly decisions that are made under time pressure or when complete information is unavailable (Kahneman & Klein, 2009). Heuristics, the subject of this study, are thought by some to benefit decision makers by providing convenient "rules of thumb" that limit the number of potential factors that contribute to decision making, and thus increase decision speed and reduce cognitive burden (Gigerenzer, 2007). However, other authors contend that heuristic-based decision making introduces inappropriate biases that negatively impact decision effectiveness (Tverksy & Kahneman, 1974). These are three examples of specific approaches to explaining the automated processes of decision making.

Finally, Behavioral Decision Theory (BDT) is an example of a dual-process model that addresses both the classical and automated aspects of decision making by suggesting that affective processes, such as heuristics, influence the ability to make decisions according to the standards of normative models (Einhorn & Hogarth, 1981; Slovic, Fischhoff, & Lichtenstein, 1977). For example, in a review of BDT, Payne, Bettman, and Johnson (1992) suggested that individuals rely on heuristics when the outcome of a decision is relatively inconsequential or when the decision is highly complex. BDT acknowledged that decisions are often complex and made in situations of uncertainty (Edwards, 1961). Accordingly, individuals may benefit from using heuristics under conditions of complexity and uncertainty because they selectively focus attention on the most important decision cues.

The role of expertise in decision making is a critical factor in whether or not individuals rely on automated or controlled decision making (Kahneman & Klein, 2009). This is because experts, when compared to novices, are more able to organize complex information, attend to a variety of cues, and disregard extraneous cues (Alba & Hutchinson, 1987; Klein, 1998). Novices are able to assess a situation and only "see what's there," whereas experts are able to see beyond the obvious and "see what's not there" (Klein & Hoffman, 1993). Expertise is contextual (Ericsson, Krampe, & Tesch-Romer, 1993), and the distinction between expert and novice is not dichotomous but rather ranges on a continuum (Benner, 1984). In sum, the higher the level of expertise a person has, the more likely he or she is to make appropriate automated decisions and have less need to rely solely on controlled decision-making processes.

The point at which automated decision making becomes appropriate given a level of expertise is unclear but may depend on decision complexity (Swait & Adamowicz, 2001). Decision complexity varies by the number of alternatives available for consideration, the number of attributes involved (e.g., information overload), the correlation between attributes, preference similarity among alternatives, and time pressure (Payne et al., 1992).

Payne and colleagues (1992) contended that individuals are more likely to use simplifying heuristics when faced with complex decisions and that novices are more likely to perceive complexity.

It is likely that winter backcountry skiers must negotiate cognitive (e.g., snowpack structure), affective (e.g., desire to have fun), and social (e.g., desire to impress others) influences when deciding to ski a particular slope. We suggest that skiing a particular slope is a complex decision that is undertaken by individuals of varying abilities, and that simplifying heuristics may often be used to reduce information overload and conserve cognitive resources.

Heuristics

Heuristics are a types of decision-making strategies often thought of as "rules of thumb" that simplify decision making by reducing the number of cues analyzed, thus reducing cognitive burden on decision makers and increasing decision efficiency (Cohen, 1993; Gigerenzer, 2007). Simon (1990) described heuristics as "methods for arriving at satisfactory solutions with modest amounts of computation" (p. 11). Some research (e.g., Tverksy & Kahneman, 1974) has focused on the disadvantages of heuristic decision making, stating that heuristics import an undesired degree of bias into decisions and, consequently, result in poor decisions. Recently, however, research has suggested that heuristics can be effective strategies for making decisions and can produce optimal results (Gigerenzer, 2007).

The foundational work of Tversky and Kahneman (1974) described three heuristics that are often used to describe heuristic thinking: availability, representativeness, and anchoring/adjustment. The availability heuristic suggests how easily an example comes to mind. For instance, if a student is asked to describe a useful theory, the student might select a theory that he or she recently discussed in a class because it is cognitively accessible. The representativeness heuristic states that humans are likely to classify objects when they are "similar in essential properties to its parent population" or "reflect the salient features of the process by which it is generated" (Tverksy & Kahneman, 1972, p. 431). Representativeness, then, is the process of making generalizations from a specific to a universal and possibly excluding other relevant data to the detriment of the decision maker. The anchoring and adjustment heuristic suggests that individuals begin with an "anchor" (an estimate) and then, as more information becomes available, adjust their estimate accordingly. For instance, in a salary negotiation, one might offer an acceptable starting wage and then adjust according to a counter-offer. These are three examples of well-known heuristics (Tverksy & Kahneman, 1974), but many others have been described in the literature. Heuristics can be personal as well as universal, and context-specific as well as context-general. For instance, one might refer to heuristics of "experts can be trusted" or "consensus opinions are always right" (Chen & Chaiken, 1999).

Avalanche-specific heuristics

The present study examined the role of the six heuristics that McCammon (2004) suggested are complicit in avalanche fatalities. These six heuristics are (a) familiarity, (b) consistency, (c) acceptance, (d) the expert halo, (e) social facilitation, and (f) scarcity. McCammon provided the following explanations of these heuristics: The familiarity heuristic suggests that skiers will ski slopes that they are already familiar with. The consistency heuristic suggests that skiers will ski the terrain they originally planned to ski. The acceptance heuristic says that men will attempt to impress women—most typically by skiing impressive, potentially hazardous terrain. The expert halo heuristic says that skiers will defer their judgment to the formal or informal leader of the group and rely on that person to make decisions. The social facilitation heuristic says that skiers will attempt to ski more hazardous terrain when other individuals are present. The scarcity heuristic argues that skiers will ski terrain that is highly coveted, features fresh snow, or is untracked. Collectively, these heuristics are involved in the decision-making of backcountry skiers in avalanche terrain, despite the potential "heuristic traps" discussed below.

Heuristic Traps

Employing any of the six heuristics identified above, McCammon (2004) stated, may serve people well in everyday life but not as well in avalanche terrain. McCammon suggested these heuristics operate on an automatic level and may result in negative outcomes. For instance, a skier might rely on the familiarity heuristic, thinking (or not) to herself "I've skied it before and it didn't slide; it should be okay this time, too." Relying on the familiarity heuristic does not guarantee that a slope is stable. McCammon labeled this potentially negative outcome to heuristic-based decision strategy a *trap,* that is, an unforeseen negative consequence associated with heuristic thinking. The term *trap* is consistent with the heuristics and biases work of Tversky and Kahneman (1974), who argued that effort reduction frameworks can lead to negative outcomes.

McCammon was not the only person in the outdoor recreation literature to use the word "trap" to suggest an unforeseen negative outcome. Clement (1997) stated that traps can negatively influence decision making for outdoor educators and suggested methods for minimizing the negative influence. Leemon and Schimelpfenig (2005) expanded McCammon's conceptualization of decision-making traps and suggested that the three types are heuristic traps, expertise traps, and analytical traps. Stremba (2005, 2009) stated that there are four types of decision-making traps that imperil outdoor leaders: heuristic traps, analytic traps, expertise traps, and random choice traps. Galloway (2005) provided a list of six heuristics used in outdoor education that could lead to traps: familiarity, social proof, commitment, scarcity, satisficing, and deminimus. Ewert, Shellman, and Glenn (2006) explored the concept of instructor traps in outdoor education. They identified eight separate traps for instructors: (a) the super-instructor trap, (b) the one-size fits-all trap, (c) the type 1 error trap, (d) the ignoring the red flags trap, (e) the Priscilla syndrome trap, (f) the meeting the train trap, (g) the assumptions of unanimity trap, and (h) the playing the power game trap. Bauch (2006) suggested that using heuristics can augment decision making, but that decision makers need to look out for traps. He commented on five of McCammon's heuristic traps and one that he calls a self-serving bias. Wheeler (2008) suggested that a "gender trap" that is based on stereotypes regarding gender identities may influence decision making in backcountry ski settings. In sum, the idea of heuristics influencing decision making in outdoor recreation has been well received and appears to translate into practical suggestions that backcountry users might be well advised to consider. The present study aimed to explore the set of heuristics that may influence the decisions made by backcountry skiers.

Risk Propensity and Avalanche Forecast

Other factors such as an individual's propensity toward risk and his or her awareness of forecasted avalanche conditions may also contribute to decisions to ski a slope. McClung (2002) argued that personality traits influence decision making in avalanche terrain and identified risk propensity as one such personality trait. The evaluation of risk is a fundamental feature of decision making that is well established within the literature (Goldstein & Hogarth, 1997; Wu, Zhang, & Gonzalez, 2005). Risk evaluation and uncertainty is evident in many of the foundational decision models such as Expected Utility Theories (Baron, 2004; Payne et al., 1992) and Cumulative Prospect Theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). Researchers have observed differences among individuals in their perceptions of risk and their predispositions to engage in risky behavior (Vong, 2007; Zuckerman, 1994). In addition, authors have extended the idea that individual associations with risk are related to heuristic decision making (Kahneman & Tversky, 1979; Payne et al., 1992; Tversky & Kahneman, 1992; Weber, Kopelman, & Messick, 2004). Because individuals perceive risk differently and perceptions of risk are likely to influence decisions to ski a slope, risk propensity provided a way to account for the influence of participant's trait level perception of risk.

Second, avalanche conditions may vary substantially from day to day, and recreational backcountry skiers may rely on avalanche forecasts published by forecasting centers to plan trips. In the United States, most forecasting centers rate avalanche hazards as low, moderate, considerable, high, or extreme. This study used the first four of these conditions as factors in the design to see how forecasted avalanche conditions might interact with heuristics in decision making. The present study combined McCammon's (2004) heuristics with individualized risk-taking propensity and forecasted avalanche conditions to predict participants' decisions to ski a slope.

Methods

Sampling

Participants in this study were students enrolled in level-one avalanche education courses certified by AIARE, a nonprofit educational organization that trains and certifies avalanche educators, who then offer a standardized curriculum through course providers. Course providers are organizations such as guide services, university programs, and municipal recreation departments. Avalanche courses teach basic concepts of avalanche science and winter backcountry travel, focusing on snowpack analysis, terrain hazards, weather systems, and decision-making strategies. Typical students in such courses consist of recreational backcountry skiers, snowboarders, and snowmobilers.

Course providers were informed of the study by AIARE and then contacted by the researchers and briefed on the details of survey administration. Course providers received information packets and passed those packets on to the course instructors, who administered the questionnaires and mailed the completed questionnaires back to the researchers. Each packet contained an explanation of the study, a letter to participants, and questionnaires. At the start of the courses, instructors asked for voluntary participation from the students, read a cover letter describing the study, and administered the questionaire. The questionairres were administered at the start of the course in an effort to limit the influence of bias that might result from participation in the avalanche education course. This was a sample of AIARE courses, in which the researchers prioritized (a) course providers who offered the greatest number of level-one courses and (b) course providers with whom the authors had personal contacts prior to the study. Based on general estimations of student registration numbers, 420 questionnaires were mailed to eight different course providers in early December 2008. Course registration numbers are unknown, although typical courses enroll between 6 and 12 students. The course providers returned 266 usable questionnaires.

The sample in this study should not be considered representative of the entire population of backcountry skiers. Study participants were interested and affluent enough to expand their understanding of winter backcountry travel by registering and paying for a level-one avalanche course. This may bias the sample toward being more conservative decision makers than the overall population of backcountry skiers when confronting avalanche hazard and evaluating snowpack stability.

Design and Instrumentation

A factorial survey design was used to determine the impact of predictor variables on the outcome variable. Factorial survey designs are appropriate for studying problems in which decisions must be made and are often used in situations where field-based experiments would be impractical, unsafe, or unrealistic (Ludwick, Wright, Zeller, Dowding, Lauder, & Winchell, 2004; Shooter & Galloway, in press; Taylor, 2006). Similar to conjoint analysis, factorial surveys present a number of varied factors and then ask participants to make a decision based on the presentation of those factors. A distinct feature of factorial survey designs is the presentation of the factors within hypothetical but realistic scenarios (vignettes). In the case of the present study, the vignettes communicated hypothetical situations that might be encountered by a group of backcountry skiers.

Participants read six vignettes and responded to those vignettes by indicating how likely they would be to ski a slope based on the combination of factors presented in each of the vignettes. The independent variables in the vignettes were *forecasted avalanche conditions* (low, moderate, considerable, and high) and the six heuristics identified by McCammon (2004). The values for each of the independent variables were randomly generated and presented in unique sets of six vignettes per survey. The forecasted avalanche conditions used one of the four levels of avalanche forecast: low, moderate, considerable, and high. The heuristics were operationalized as dichotomous variables. For example, the skier was said to be either familiar or not familiar with the terrain. The heuristics were operationalized consistent with McCammon's (2004) operational definitions of these variables to the exclusion of other explanations. Each vignette was introduced as a 33-degree slope. A sample vignette is:

> You are part of a group that is out for a day of backcountry skiing. The avalanche forecast states that the avalanche hazard is HIGH. You have chosen to ski terrain that YOU HAVE SKIED MANY TIMES BEFORE. You have a HIGH commitment to skiing the line you intend to ski. You are in a MIXED-gender group. There IS a clearly defined leader in your group suggesting you ski the slope. During your approach you saw NO other parties. You plan to ski an UNtracked slope.

In this vignette, the seven variables (capitalized), in order of appearance, are: avalanche forecast, familiarity, consistency, acceptance, expert halo, scarcity, and social facilitation. The dependent variable was *likelihood to ski,* and participants responded to each vignette by indicating the likelihood that they would ski a slope (on a scale of 1–7). While the decision to ski a slope is ultimately a yes or no choice, a continuous measure is an appropriate choice because we are not trying to predict the decision itself, but trying to understand the uncertainty of the decision-making process.

To account for the trait-based influence on decisions to ski a slope, an eighth independent variable, *risk-taking tendency*, was also measured. The Stimulating Risk Inventory (SRI), a ten item, trait-based measure of risk-taking tendency, provided indicators of participants' own tendency to take risks. Zaleskiewicz's (2001) risk-taking scale centers on *stimulating risk-taking*, such as the risks one might encounter while skiing in avalanche terrain. The SRI is part of a two dimensional measure known as the Stimulation-Instrumental Risk Inventory (SIRI), which was constructed to measure dual-process decision making (rational and intuitive) (Zaleskiewicz, 2001). In two separate experiments, both Zaleskiewicz

(2001) and Vong (2007) found evidence for a two-factor structure of risk-taking decisions. Zaleskiewicz reported Cronbach's alpha values of .76 and .82, and Vong (2007) reported a Cronbach's alpha value of .71 for the SRI. Further, Zaleskiewicz (2001) reported that the SRI was related to the "thrill and adventure" and "disinhibition" dimensions of Zuckerman's Sensation Seeking Scale (Zuckerman, 1994, pp. 31–32). The SRI was chosen for its foundation in heuristic-based decision making, ease of administration, and because it is "related to the preference for recreational risks [among others]. It is associated with personality features connected with paratelic orientation, arousal seeking, impulsivity, and strong sensation seeking" (Zaleskiewicz, 2001, p. 105). These conditions may be similar to those encountered in a backcountry skiing context. Two sample items from SRI are: "I am attracted by different dangerous activities." and "I make risky decisions without an unnecessary waste of time."

Collecting data from six unique vignettes per participant, as well as trait-based data from the SRI, resulted in a multilevel data set. This provided data at the vignette level (level one) and at the individual participant level (level 2). Level one included the six measures of respondent's likelihood to ski a slope. Level two represented each respondent's mean score on the SRI. To summarize, each participant responded to six unique vignettes, to the SRI, and to a series of questions used to provide general information about the participants.

Data Analysis

At the conclusion of each vignette, participants responded to the following: "You have now arrived at the top of the run. How likely are you to ski this slope?" The anchors to the 7-point Likert-type scale were *extremely unlikely* and *extremely likely*. Mean scores were calculated for each individual's level of risk-taking tendency based on scores from the SRI. A set of participant-based questions provided additional information regarding backcountry skiing experience (number of years skiing in the backcountry), preferred mode of travel, perceived skiing ability, confidence to evaluate avalanche hazards, sex, and age. Descriptive statistics were used to analyze the participant-based data and to provide a summary of information about the participants in the study.

Data were entered into SPSS version 15.0, cleaned and screened for missing and incorrect entries, and then transferred into hierarchical linear modeling (HLM) software, edition 6. The data were analyzed using HLM, which is a regression-based multilevel modeling approach to data analysis (Luke, 2004). This is consistent with factorial survey designs, which call for a regression-based approach to data analysis (Ludwick et al., 2004). The level one model included the grand centered measure of the forecasted avalanche conditions and heuristic traps on intention to ski. The level two model accounted for the differences of trait level risk aversion among individual respondents.

An initial null model was tested first to determine if there was sufficient variance among participants to proceed with HLM analysis, and to provide an error term for future calculation of the amount of variance explained by the full model. A full model was constructed to test the effect of forecasted avalanche conditions, the six heuristics (level 1) and risk-taking tendency (level 2) on decisions to ski a slope. The orthogonal design tested the relative effects of the level one predictor variables by examining the standardized regression coefficients of each predictor (Karren & Barringer, 2002).

Results

Descriptive Statistics

Descriptive statistics were calculated at both the scenario (n = 1596) and participant (n = 266) level data. The majority of participants were male (76%, n = 201). Most preferred

TABLE 1 Descriptive Statistics for Age, Risk Taking Tendency, Skiing Experience, and Likelihood to Ski

Item	Mean	SD	Range	Minimum	Maximum
Age	29.53	9	48	14	62
*Risk Taking	2.24	.45	2.40	1.30	3.70
Ski Experience	3.76	5.87	45	0	45
Likelihood to Ski	4.29	1.86		1	7

*Risk Taking: $\alpha = .72$

skiing as their primary mode of snow travel (62%), followed by snowboarding (21%), snowshoeing (13%), and snowmobiling (2%). Skiing ability ranged from beginner to elite, but most participants were intermediate (21%), advanced (32%), or expert (33%).

Table 1 displays descriptive statistics for age, risk-taking tendency, skiing experience, and likelihood to ski a slope. The average age was 29.53 years and ranged from 14–62. The average number of years skiing was 3.76 and ranged from 0–45. The mean of overall risk taking was 2.24 ($n = 266$, $SD = .45$), on a four point scale where four represents "describes me very well." Likelihood to ski scores ranged from 1–7 (7 = very likely), with an overall mean scores of 4.29 ($n = 1596$, $SD = 1.86$). When the avalanche forecast was *low*, the mean likelihood to ski a slope was 5.91. When it was moderate, the mean likelihood to ski a slope was 4.73. When it was *considerable*, the mean likelihood to ski a slope was 3.69. When the avalanche hazard was *high,* the mean likelihood to ski a slope was 2.76 (see Figure 1).

Model Testing

The first step of hierarchical linear modeling (HLM) is to test an unconstrained model that excludes all predictors. Table 2 displays the results of the unconstrained model test. The

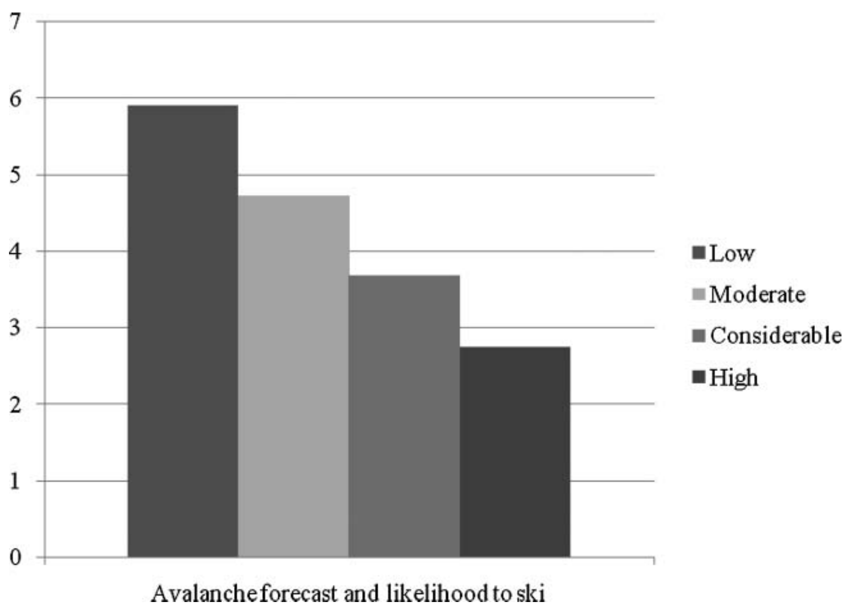

FIGURE 1 Mean likelihood to ski scores and Forecasted avalanche conditions.

TABLE 2 Final Estimation of Variance Components: Unconstrained Model

Random effect	*SD*	Variance Component	*df*	Chi-square	P-value
u_{ij}	0.66	0.43	265	492.35	<.01
r_{ij}	1.74	3.02			

significant *p* value in this test indicates that there is enough variance within the scores to proceed with further multilevel model testing. Results from the null model also provided estimates of the variance at level one and level two, which allowed for calculation of amount of variance explained. Following the results of the significant null model test, an initial full model was constructed to explore the causal relationships within these data. The level one model included grand centered measures of the following main effects predictor variables: avalanche forecast, familiarity, commitment, gender, leader, alone, and untracked. The level two model consisted of the mean scores on risk-taking tendency based on the SRI for each participant. Table 3 displays the results of the full model, and Table 4 displays the final estimation of variance components for the full model.

Results indicate that risk-taking tendency ($\gamma 01 = .43$, $t = 3.62$, $p < .01$), forecasted avalanche conditions ($\gamma 10 = -1.10$, $t = -31.26$, $p < .01$), familiarity of the terrain ($\gamma 20 = .58$, $t = 9.11$, $p < .01$), commitment to ski a given slope ($\gamma 30 = .18$, $t = 2.85$, $p < .01$), the presence of a leader in the group ($\gamma 50 = .43$, $t = 7.28$, $p < .01$), the presence of other skiers in the area ($\gamma 60 = .29$, $t = 4.83$, $p < .01$), and the desire to ski an untracked slope ($\gamma 70 = .64$, $t = 10.81$, $p < .01$) predicted the likelihood that participants would ski a slope. However, whether or not the group included members of all the same gender or consisted of a mixed gendered group ($\gamma 40 = -.01$, $t = -.18$, $p > .05$) did not predict decisions to ski a slope. Figure 2 displays the relative influence of each significant level one predictor on the likelihood to ski a slope.

Discussion

The purpose of this article was to understand the role of heuristic-based decision-making factors, risk propensity, and avalanche conditions on the decision to ski a particular slope. Five of the six heuristics identified by McCammon (2004) played a role in predicted decision

TABLE 3 Full Model: Final Estimation of Fixed Effects on Likelihood to Ski a Slope

Fixed Effect	Coeff	SE	t	df	p
Intercept $\beta 00$	3.33	.28	11.92	264	<.01
Risk $\beta 01$	.43	.19	3.62	264	<.01
Forecast $\beta 10$	−1.10	.04	−31.26	1587	<.01
Familiar $\beta 20$	.58	.06	9.11	1587	<.01
Commitment $\beta 30$	.18	.06	2.85	1587	<.01
Gender $\beta 40$	−.01	.06	−0.18	1587	.86
Leader $\beta 50$	.43	.06	7.28	1587	<.01
Alone $\beta 60$	.29	.06	4.83	1587	<.01
Untracked $\beta 70$	.64	.06	10.81	1587	<.01

$R^2 = .48$

TABLE 4 Final Estimation of Variance Components: Full Model

Random effect	*SD*	Variance Component	*df*	Chi-square	P-value
u_{ij}	0.76	0.58	264	1033.21	<.01
r_{ij}	1.10	1.20			

to ski a particular slope among avalanche level one students. Forecasted avalanche conditions and risk-taking tendency also influenced decisions to ski. We begin this discussion by considering the influence of McCammon's heuristics.

An untracked slope was positively related to one's likelihood to ski. McCammon (2004) named this factor *scarcity*, a reference to the rarity of specific conditions valued by skiers, including finding an unskied slope, being first down a run after snowfall, or taking the best possible line or route down a slope. Skiing untracked powder is among the greatest of backcountry rewards and appears to be highly influential. The behavioral activation system (BAS) suggests that individuals are motivated to behave in a way that maximizes reward, hope, and elation (Fowles, 1981; Gray, 1990) and may play a role in backcountry skiers choosing to ski a rewarding slope despite avalanche conditions. Carver and White (1994) stated that "greater BAS sensitivity should be reflected in greater proneness to engage in goal-directed efforts and to experience positive feelings when the person is exposed to cues of impending reward" (p. 319). Backcountry enthusiasts should remain vigilantly attentive to the objective hazards and not allow the opportunity for fresh turns on an untracked slope to lure them away from sound judgment.

Further, McCammon argued that individuals are more likely to take risks in the presence of others, which he called *social facilitation*. He operationalized social facilitation by noting whether or not skiers encountered other parties while in the backcountry. Results from this study suggest that encountering other parties was positively related to the likelihood to skiing a slope. Underlying causes for the influence of this factor remain unclear. It could be that encountering other parties lures people into a false sense that the conditions are stable. It could also be that they become inspired to show off. Or, skiers could be influenced by the competition for scarce resources. Given the lack of precision in the operational

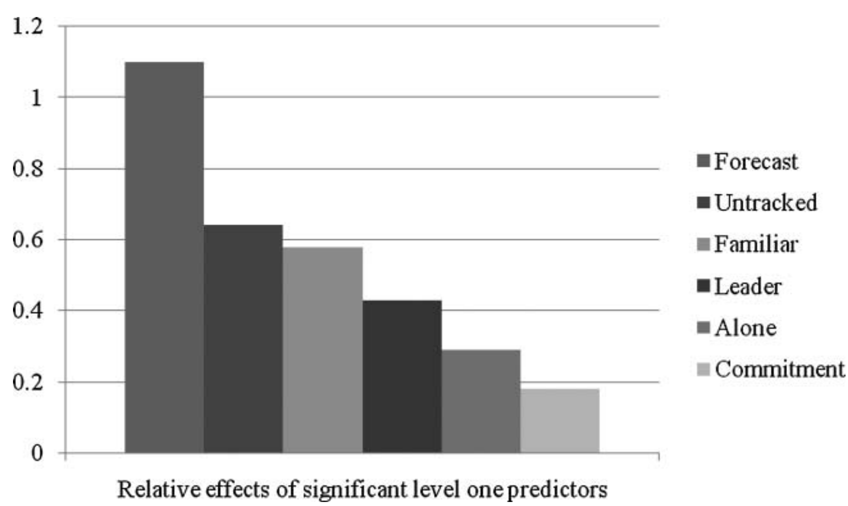

FIGURE 2 Significant main effects on likelihood to ski a slope.

definitions, perhaps clarifying the ambiguity between scarcity and social facilitation would be an avenue for future study.

Familiarity with a slope was positively related to the likelihood of skiing a slope. As individuals experience positive rewards associated with skiing a particular slope without negative consequence, they build an association with the positive outcome. This is consistent with the work of Damasio, Tranel, and Damasio (1991), who suggested that humans form *somatic markers* that influence future decisions under similar circumstances. Somatic markers represent intuitive knowledge that is based upon emotional reactions (or "markers") of past experiences. If a skier forms positive associations from skiing a particular slope without incident, then according to the somatic marker hypothesis, he or she may intuitively believe that the slope is stable, and possibly disregard critical snowpack information that would suggest otherwise. Familiarity may also be related to habituation, where individuals repeat past behavior out of habit (Aarts, Verplanken, & van Knippenberg, 1998). However, Ajzen (2002) stated that when attitudes and intentions are strong, individuals are less likely to be guided by habit. Prudent backcountry skiers should remember that their attitudes and intentions towards avalanche hazard should remain strong enough not to be lured into familiar habits that may not be safe. They should also remember that that avalanche conditions vary not only from day to day but also from hour to hour, and that just because a slope was stable at one point does not mean it will be at a later time.

Having a leader in the group was positively associated with the likelihood of skiing a slope. McCammon (2004) suggested that skiing accidents were more likely when a group failed to rely on its own judgment by abdicating decision making to a leader. This heuristic may be related to groupthink theory, which suggests that cohesive groups make decisions without critically vetting them. In a review of empirical groupthink studies, Esser (1998) suggested that laboratory studies examining groupthink theory have yielded consistent support for groupthink predictions concerning the relationship between a directive leader and followers who do not contribute to the decision process. Although backcountry ski leaders may not be known for directive leadership styles, abdication of power by followers based on the perceived competency of the leader may move them into that role. Similarly, Callaway and Esser (1984) found that groups that were highly cohesive and lacked adequate decision rules exhibited less disagreement and generally made worse decisions than other groups. While the influence of having an appointed leader may not be fully understood, winter backcountry users are encouraged to establish group norms regarding who will be responsible for making decisions and what will be involved in that decision-making process. This negotiation may include a discussion about values, as recommended by DiGiacomo (2007), which can shed light on how much risk each individual is comfortable accepting. Having this discussion before entering the backcountry will establish group norms from the outset.

Finally, commitment to ski a slope was positively associated with the likelihood of skiing that slope. The process of being committed to one's goals bears a strong similarity to *behavioral intention*, an antecedent to behavior identified in Ajzen's theory of planned behavior (Ajzen, 1991). Ajzen maintains that individuals' intentions are likely to inform behavior and that the more strongly held the intention, the more likely the behavior is to occur. Prudent backcountry skiers should remember that the primary intention should be to not get caught in an avalanche and to use snowpack observations, rather than antecedent commitment to a goal, to inform decisions. A singular focus on a goal in the face of environmental factors can have dire consequences. A sixth heuristic did not significantly influence predicted decision making. McCammon (2004) stated that men are likely to ski more hazardous terrain when in the presence of women in order to impress them, but support for this hypothesis was not found in our study. Although research exists to support how social interaction among men and women alters behavior, there is also research pointing out how men are competitive with other men (e.g., McGrath, 1984). Thus, the acceptance heuristic may apply regardless of sex. Wheeler (2008) agrees that the acceptance heuristic may be flawed as McCammon operationalized it; she suggested that all-women ski groups can be fiercely competitive and that, in general, gender dynamics are so complex that they easily defy a single rule of thumb. In the present study, this insignificant factor may be an artifact of a limited operational definition. The idea of taking risks in the presence of others as a means to gain acceptance is worthy of further attention. Likewise, understanding the role of group dynamics in the backcountry context and clarifying the difference between social influence and heuristic decision making emerge as avenues for further study.

In order of most influential to least influential, the factors positively associated with the decision to ski were (a) an avalanche forecast that suggested minimal hazards, (b) that the slope was untracked, (c) whether skiers were familiar with the slope, (d) that there was a leader in the group, (e) that there were other skiing parties present, and (f) that the skier was committed to skiing a particular slope. The fact that avalanche forecast was the most critical factor in deciding to ski a slope warrants specific discussion.

When the forecasted avalanche hazard was *low*, respondents were most likely to ski. This relationship between forecast and decision to ski followed an expected trend through the *moderate* and *considerable* forecasts, with average scores on likelihood to ski a slope progressively and markedly decreasing (Figure 1). When the avalanche hazard was *high,* respondents were least likely to ski the slope. This supports the notion that avalanche forecasting centers play an important role in the decision-making of wintertime backcountry users.

There are 23 avalanche forecast centers in the United States (http://www.avalanche.org, n.d.). Forecast centers are typically funded by a number of sources, from state government agencies to philanthropic donations to corporate support. Forecasts often provide information regarding snow conditions, weather, and degree of avalanche hazard based on elevation and aspect (aspect being the cardinal direction that the slope faces, e.g., northwest, south). Based on our results, the information provided by avalanche forecast centers is a critical factor in skier decision making. This information provided by forecasting centers should be as accurate and current as possible and that continued funding of these centers is critical as they provide a valuable public service.

In addition to heuristics and avalanche forecasts, backcountry users bring varying levels of risk-taking propensity into the decision process. Risk-taking propensity was positively related to the decision to ski a slope. Although authors have suggested that individuals hold varying degrees of tolerance for risk taking in avalanche terrain (DiGiacomo, 2007; McCammon & Haegeli, 2005), this factor has not been explored empirically as a control in heuristics-based decision-making models (e.g., Ewert et al., 2006; McCammon, 2004). The present study's results indicate that this factor is important and suggest that backcountry users should remain aware of how their own propensity to take risks in avalanche terrain might influence the group decision-making process.

Future Research

In light of the findings of this study, several directions for future research become clear. First, researchers might examine how a decision process is linked to an avalanche likelihood outcome. For example, the ALPTRUTH decision-aid (McCammon & Hageli, 2007) could be used to assign an avalanche likelihood, as could an "exposure score" similar to the one that McCammon used in his 2004 study. An exposure score is an aggregate measure of how much avalanche hazard is present during a particular ski run. By comparing one of these measures to a vignette-based scenario like the ones used in this study, researchers may gain further insight into the role of heuristic traps in avalanche terrain. Second, researchers might focus on how classical, deliberative models of decision making are related to backcountry ski accidents. It is likely that even the most deliberative and informed of skiers are still caught in and injured by avalanches, and understanding how these models of decision making regard decisions to ski will provide a comparison to heuristic-based injuries. Third, researchers might address the frequency with which heuristic-based decision making leads to good decision making. Fourth, researchers should focus on empirically investigating the value of particular heuristics rather than developing new, untested ones. As Broder (2003) stated, "inventing more and more new heuristics may soon become futile if they are not seriously tested empirically" (p. 622).

Limitations

There are a number of limitations to this study. Factorial surveys are useful for studying situations that do not lend themselves well to field-based experiments. However, the scenarios used in this study only offer a hypothetical simulation or an approximation of the real life situation. Further, there is a risk of carryover effect; that is, as respondents read one vignette, they might be influenced by one of the previous vignettes they read (Sniderman & Grob, 1996). Second, the sampling frame only examines skiers who are enrolled in avalanche education courses, so generalizability is limited. Third, this study addressed six heuristics as they have been represented in McCammon's work; however, a true heuristic decision-making process may exclude deliberation. The extent to which research participants deliberated during their responses to the vignettes is unknown; however, the act of deliberation may influence results undesirably.

Conclusion

In a broad sense, the goal of this research was to promote safe wintertime leisure experiences by understanding the factors that influence decision making in avalanche terrain. Taken as a whole, decision-making studies conclude that decisions are not only made through controlled, rational and logical processes but also include an automated process that involves intuition, heuristics, and affect. This may be particularly important in the case of backcountry skiing where decision complexity, reliance on past experiences, and sensation seeking may be high. Decision making may be further complicated by the fact that decisions are made within small group settings rather than by individual actors. Future research can help clarify the roles of different types of decision processes and their impacts on decision making.

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