

TEMPERING COGNITIVE BIAS WITH BEST-PRACTICE, A SURVEY OF ALASKAN BACKCOUNTRY SKIERS & RIDERS

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ABSTRACT: This paper describes survey data collected over four winter seasons (2019-2022) from 736 responses of backcountry skiers and riders across Alaska. In an effort to determine how human and cognitive factors impact decisions in the backcountry, we asked a series of survey questions including demographics; questions about winter backcountry practices; and avalanche skills, equipment, training, and risk perception. Of note, around a third of our respondents had been in an avalanche regardless of gender and age. Respondents with greater exposure to avalanche conditions (because of greater frequency and duration of backcountry winter recreation) were more likely to be caught in an avalanche or have a near miss. Many of our respondents used decision-making paradigms (ALPTRUTH/ Red Flags) and mitigation and communication technologies (avalanche transceivers, airbags, radios, satellite communication, GPS) to manage the inherent risks of avalanche terrain and the complexities of the backcountry, though use of these tools was not associated with a lower likelihood of being caught in an avalanche. Almost all of our respondents had some level of avalanche education, most had a Recreationalist Level 1, while some were advanced recreationalists and professionals. As our survey data suggests, the adoption of best practice protocols in avalanche terrain has been partly successful, though we find that respondents with greater avalanche education are more likely to be caught in avalanches, even after controlling for frequency and duration of backcountry winter recreation. Avalanche education should be a continued focus of social science research as applied to the psychological and sociological motivations of backcountry skiers and riders.

KEYWORDS: human factors; cognitive bias; decision making; exposure; motivations

1. INTRODUCTION

This study explores how Alaskan backcountry skiers and riders engage, manage, and perceive the risks associated with travel in avalanche terrain. Over a period of four winter seasons (2019-2022), we ran a survey that asked questions about where, how, and why people travel in avalanche terrain, whether or not they had been in an avalanche or responded to one nearby, what level of formal avalanche training they held and whether they were vocationalist professionals or avocational recreators, what kind of decision making tools and checklists they used, what kind of mitigation and communication technologies they used, and whether their past experiences in avalanche terrain affected their risk perception and overall sense of security while in the snowy mountains.

From our 736 responses, we then identify that exposure, more than any other variable, determines whether or not our participants had been in an avalanche or had a close call. We then discuss what insights this data offers for making us more informed in the backcountry. We review relevant literature on cognitive biases with a special focus

on perception and motivations, and explore the role of authentic education in the form of mentoring as an experiential pathway for making informed decisions while managing avalanche risk.

Since McCammon's initial work on heuristic decision making (2009), the role of heuristic and cognitive bias, our so-called human factor, in slope-scale decisions has been heavily emphasized at various levels of avalanche education. As Johnson et al. point out (2020), the anchoring of avalanche education on human factor and heuristic traps has overlooked some important limitations of what the concepts describe and how to operationalize them.

A large part of the challenge of describing and understanding avalanche danger is that the hazard is spatially variable and we the human decision-makers may lack the vocabulary or experiential knowledge to adequately forecast or nowcast the actual instability. Statham et al.'s work (2018) on a conceptual framework for understanding and managing the complexities of avalanche terrain has done much to reduce complexity and provide a common vocabulary for forecasters and snow professionals. In a similar way, Atkins's work on

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strategic mindset (2014) and Zacharias's work on terrain mindset (2021) offer a framework for professionals and recreationalists to navigate risk perception as it relates to the forecast, and make large strides toward using intentionality and mindfulness techniques as tools for accepting uncertainty and approaching avalanche terrain with a conservative perspective.

More recently, Boilen and Dassler (2024) published a human problem conceptual model describing cognitive biases on a human-human and human-nature continuum. Grounded in current social-psychological research, Boilen suggests that our primary biases are over/under estimation, perception, fallibility, uncertainty, motivation (drive/desire), emotion, and peer influence, anchored in relation to ourselves, others, and nature.

2. METHODS

In order to better understand risk-taking in the context of avalanche safety, we recruited survey participants using social media and through outreach to several avalanche safety organizations. We targeted snow-sports recreationalists in Alaska, USA, our home state, though some out-of-state skiers and riders also completed the survey. Participants were asked 34 questions including demographic questions (age, sex, location), questions on avalanche risk perception, training, behaviors while traveling in avalanche terrain, and exposure to avalanches. This data was gathered in four waves over a period of four winters, starting in winter 2019 and concluding in 2022.

This resulting dataset is a convenience sample and not randomly selected, and no comprehensive data source exists which allows us to characterize the Alaskan snow sports demographic. However, our data appears to match the demographic characteristics of the backcountry skiing and riding communities we observe in the mountains; our sample is largely White (96%) and male (70%), the mean sample respondent was born in 1982 with most respondents born between 1975 and 1995, though our oldest respondent was born in 1942 and our youngest was born in 2005. Because—like the backcountry skiing and riding population in general—our sample skews young, with many respondents under the age of 25 (and presumably still in college or high school) we judged questions about income and education levels to be poor controls for wealth and social class. As a better proxy for class, we asked about family education levels and most respondents described their mothers' level of education as college-level and above (76%), suggesting that our sample, like most Alaskan backcountry skiers

and riders we meet, come from middle-class backgrounds and above.

We analyze our dataset using several cross-sectional time-series multivariate regression techniques, as described below, in "Findings".

3. FINDINGS

Our most significant and striking finding is that the most important driver of avalanche risk (as measured by the respondent's likelihood of being caught in an avalanche and/or having a near miss) is exposure to avalanche terrain when avalanche conditions are present, i.e. time spent in the mountains in winter. Other variables largely fail to mitigate this relationship. To measure exposure to avalanche risk we use two dependent variables. The first of these is "Caught in Slide," coded 1 if the respondent reports ever having been caught in an avalanche and 0 otherwise. Note that we make no attempt to differentiate between types of avalanches, size or other avalanche characteristics. We also use a measure of whether respondents have ever had a "Near Miss," coded 1 if the respondent reports ever having almost been caught in a slide and 0 otherwise. Based on these two variables, we create a third dependent variable, "Caught or Near Miss" coded 1 if the respondent has either reported having been caught in an avalanche, having almost been caught or both. To examine the drivers of avalanche risk, we estimate cross-sectional, time-series logistic regression models. To address potential problems of serial autocorrelation—because a number of respondents completed our survey in two or more years—we use standard errors robust to clustering at the level of the individual respondent. These regression results are shown in table form in Table 1.

	Dependent Variable		
	Caught in Slide	Near Miss	Caught or Near Miss
Sex	-1.88 (.05)*	-1.43 (.031)*	-1.66 (.03)*
Birth Year	-.01 (.70)	-.01 (.08)	-.01 (.76)
First Year	-.11 (.01)**	-.08 (.001)***	-.11 (.002)**
Days Skiing	.94 (.03)*	.87 (.001)***	.91 (.003)**
Training	1.08 (.01)*	.30 (.161)	.41 (.13)
Terrain	1.01 (.03)*	1.35 (.001)***	1.71 (.001)***
Observations	324	321	324
Groups	235	235	235
Wald chi-squared	19.27	25.79	23.61

Log pseudolikelihood	-137.03	-160.69	-152.74
P values in parentheses * p < .05; ** p < .01; *** p < .001			
Table 1: Exposure drives avalanche risk.			

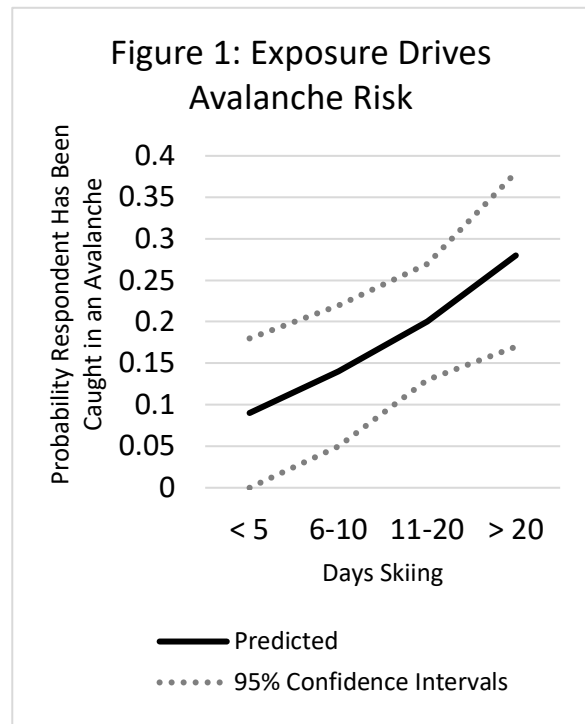
In general, we find that respondents who have been skiing and/or riding in the backcountry for a longer amount of time (as measured by the variable “First Year”—the first year each respondent went backcountry skiing or riding) are more likely to have been caught in a slide, more likely to have had a near miss, and more likely to have been caught in a slide or a near miss.

Similarly, respondents who report skiing more days per year (“Days Skiing”) have a higher likelihood of having been caught in a slide, having had a near miss or both. We show this relationship in Figure 1, which shows the predicted likelihood of being caught in a slide given responses on “Days Skiing.” Where respondents report spending fewer than five days annually skiing or riding in the backcountry, their probability of being caught in an avalanche is about .1 (i.e., about 10%). But for respondents that report spending more than 20 days a year in the backcountry skiing or riding, the likelihood of being caught in an avalanche nears .3 or 30%.

We include in these three models control variables for sex (1 = Male, 2 = Female), avalanche training (1 = no training, 2 = a short informational session, 3 = recreational avalanche 1, 4 = recreational avalanche 2, 5 = more than recreational avalanche 2), and terrain (1 = respondent skis “no steep terrain” in the backcountry, 2 = “very little steep terrain,” 3 = “some steep terrain,” 4 = “mostly steep terrain”).

An interesting secondary result in these models is that avalanche training is not significantly associated with avalanche risk where the dependent variable is “Near Miss” or “Caught or Near Miss”. And training is *positively* and significantly associated with “Caught in Slide,” meaning that respondents with a higher level of training are more likely to have been caught in an avalanche, *ceteris paribus*. This may reflect a tendency for individuals to seek out a higher level of training when they expose themselves to a higher level of risk; apparently additional training does not fully mitigate additional risk, on average.

Finally—like other scholars—we find that female skiers and riders are less likely to be caught in a slide, experience a near miss, or both.



We also use our data to estimate a second set of models as a way to better understand avalanche safety practices in the field. Our survey includes questions about safety equipment; whether and how frequently respondents carry avalanche beacons, shovels and probes, whether they use avalung devices or avalanche airbags, whether they ski/ride with or without a helmet and what communications gear they carry, if any. We also ask whether respondents use heuristic devices (“Red Flags,” “ALPTRUTH” etc...) to make decisions while traveling in the backcountry.

Here, our results are somewhat less discouraging. In general, we find that avalanche training is positively associated with the likelihood that respondents carry safety gear, use heuristic devices, practice with their avalanche beacon, and dig snow pits while traveling in the mountains.

We also find evidence of a mentoring or diffusion effect; skiers’ and riders’ safety behaviors are strongly correlated with the reported practices of their most experienced skiing or riding partner. We show this relationship in Figure 2. Where a respondent’s most experienced partner does not always carry a beacon, around 78% of respondents likewise don’t always carry a beacon. Where respondents’ most experienced partners always carry a beacon, this relationship is almost exactly reversed, with about 78% of respondents always carrying their own beacon.



Table 2 shows three models examining the correlates of avalanche safety practices. The first dependent variable, “Heuristic” is the self-reported frequency with which each respondent uses a hazard evaluation heuristic such as red flags or ALPTRUTH (1 = “never,” 2 = “some days,” 3 = “most days,” 4 = “every time,” 5 = “several times a day”). “Beacon practice” is a measure of how recently respondents practiced with their avalanche beacon (1 = “In the last few weeks,” 2 = “In the last few months,” 3 = “A year ago or more”). “Forecast” is the frequency with which the respondent checks the local avalanche forecast (1 = “Never,” 2 = “Some days,” 3 = “Most days,” 4 = “Every time”). We use similar control variables to those in Table 1, including Sex, Birth Year, First Year (i.e. first year skiing/riding in the backcountry), Days Skiing (per year), and Terrain (how often the respondent reports skiing steep terrain). We also use “Training,” the same measure of avalanche safety training used in Table 1 and we add “Partner Uses Heuristic,” “Partner Practices” with their beacon, and “Partner Checks Forecast.” These variables measure—unsurprisingly—whether the respondent’s most experienced backcountry skiing/riding partner uses hazard evaluation heuristics such as Red Flags or ALPTRUTH, practices with their beacon, and checks the avalanche forecast. All three of these variables are dichotomous (0 = “No,” 1 = “Yes”).

Here, we find that higher levels of avalanche safety training are associated with a higher probability that respondents will use heuristic devices and will have more recently practiced with their beacon.

Dependent Variable			
Heuristic	Beacon Practice	Forecast	

Sex	-.27 (.35)	.43 (.09)	-.10 (.74)
Birth Year	.01 (.21)	-.00 (.27)	.001 (.63)
First Year	.01 (.14)	-.01 (.24)	.001 (.56)
Days Skiing	.34 (.003) **	-.16 (.20)	-.03 (.84)
Terrain	-.24 (.13)	-.06 (.71)	-.33 (.12)
Training	.52 ($<.001$) ***	-.31 (.01) **	.16 (.21)
Partner Uses Heuristic	3.07 ($<.001$) ***		
Partner Practices		-1.29 ($<.001$) ***	
Partner Checks Forecast			2.49 ($<.001$) ***
Observations	321	311	319
Wald chi-squared	138.39	53.81	32.00
Log pseudolikelihood	-370.39	-312.43	-278.94
P values in parentheses * $p < .05$; ** $p < .01$; *** $p < .001$			

Table 2: Training and mentoring is associated with avalanche safety practices

We also find that “Partner Uses Heuristic” is strongly and significantly associated with “Heuristic,” “Partner Practices” [with their beacon] is strongly and significantly associated with “Beacon Practice” and “Partner Checks Forecast” is strongly and significantly associated with “Forecast.” These strong and statistically significant relationships indicate that skiers/riders are more likely to follow commonly recommended avalanche safety practices if their skiing/riding partners also follow those practices.

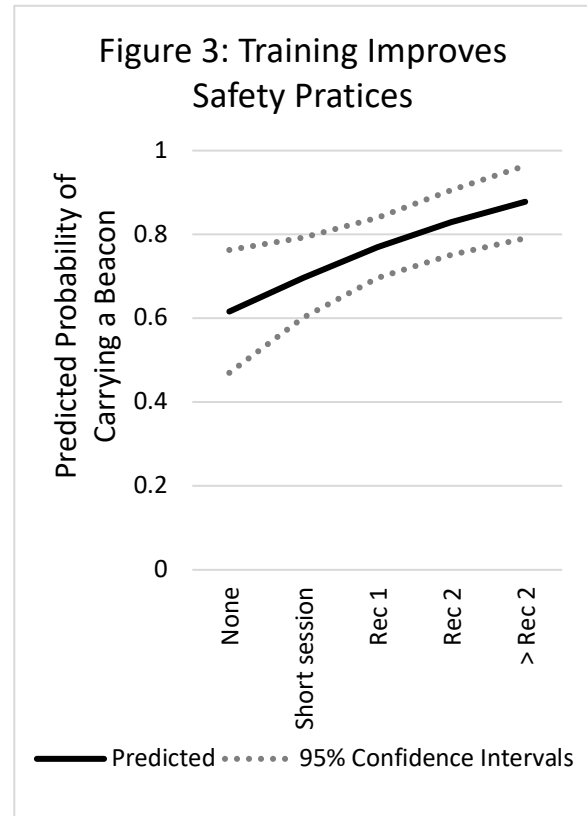
Finally, we present in Table 3 a cross-sectional, time-series regression model examining the correlates of safety equipment usage in the backcountry. To generate an overall measure of safety equipment usage, we take each respondent’s average response across three questions: “How frequently do you carry a beacon?”; “How frequently do you carry a shovel?” and “How frequently do you carry a probe?” All three of these questions are coded 1 = “Never,” 2 = “Half the time or less,” 3 = “Most of the time,” 4 = “Always.” Taking the average of these three questions within each respondent creates a continuous measure (“Safety Gear”) with a range from 1 to 4 where 1 means the respondent never carries any of the three items and where 4 means they always carry all three items. We include this measure as the dependent variable in a cross-sectional, time-series regression model with random effects and standard errors robust

to clustering at the level of the individual respondent. This model, shown in Table 3, shows the relationship between avalanche training ("Training") and the use of safety gear. In sum, training is significantly associated with more frequent carrying of beacon, shovel, and probe.

	Dependent Variable Safety Gear
Sex	.07 (.40)
Birth Year	.00 (<.001)***
First Year	.02 (<.001)***
Days Skiing	.02 (.60)
Terrain	.25 (<.001)***
Training	.14 (<.001)***
Constant	-34.43 (<.001)***
R-squared	.25
Observations	324
Groups	235
p values in parentheses	
* p < .05; ** p < .01; *** p < .001	

Table 3: Training is associated with the more frequent use of safety gear

Although this relationship is strong and statistically significant, the compound measure of safety gear use is somewhat difficult to interpret so we also estimate a cross-sectional, time series logit model using only the probability a respondent will always carry an avalanche beacon while skiing or riding in the backcountry. This model uses the same control variables and shows similar results as those in Table 3. We omit this regression table in the interest of space but include a figure showing the relationship between avalanche training and the likelihood of carrying a beacon. While skiers and riders at all levels have a high probability of always carrying a beacon, this probability increases from about 60% for respondents with no training to around 90% for respondents with the highest level of training.



4. DISCUSSION

We know that decision-making in the backcountry is a complex process. Even so, Mannberg et al.'s work (2018) on the expert halo effect may relate well with our findings that increased exposure to avalanche risk (avalanche conditions in avalanche terrain) results in a higher likelihood of being caught in an avalanche. Mannberg found that those who had a close call or were caught in a slide were more likely to rate their skills and decision-making in the backcountry higher than those who had never been caught or nearly so. Discouraging as this data may be, Mannberg offers two possible explanations: that even with feedback from poor decisions, individuals fail to update their beliefs, and those who believe themselves to be skilled are more likely to have accidents.

Returning to Boilen and Dassler (2024), and their conceptual model of the human problem, a few cognitive biases seem especially relevant here, although almost all relate. We are far better at seeing biases in others than in ourselves. This is where the use of slope scale data (traveling tests, snow pits) and decision-making tools (ALP-TRUTH/ Red Flags) can positively influence perception. Likewise, our motivations can blind us. We have conscious and unconscious drives, and the desirability and confirmation biases at times highlight what we actually see, and also what we expect and hope to see. Managing motivations

with a culture of communication, one where value is placed on talking about goals, feelings, and motivations through active inquiry, the asking of questions, and advocacy, supporting and creating space for those questions to be asked, can help manage these biases.

That our most experienced and well-trained backcountry users are also the most exposed, and thereby most likely to have been caught in an avalanche, is offset to some extent by this advanced to expert group's adoption of safety practices. Our most experienced respondents continued to value and pursue avalanche safety education and training and regularly carried and practiced with their companion rescue equipment. In our data, 7 out of 10 respondents noted that their most experienced partners always traveled with avalanche companion rescue equipment, and regularly practiced with it. That backcountry users, especially advanced and expert ones, value safety skills and practice with their equipment, is a *cause celebre* for the adoption of life-saving measures that minimize avalanche risk.

That being said, some of what is at stake here is the uncertain and inherently low-feedback nature of avalanche terrain, especially in Alaska and more remote backcountry areas where a professional avalanche forecast is often unavailable. That survivors of a close call or avalanche think they make better decisions in the backcountry because of that experience, as Mannberg's data suggests, and that exposure is the single largest factor relating to whether a person in our study had been caught in an avalanche, are sobering observations about our abilities to navigate avalanche risk. Even so, identifying our cognitive biases through Boilen's conceptual model of the human problem, and also operationalizing citizen science by reporting and sharing observations at our existing regional avalanche information centers, has significantly increased awareness of existing avalanche hazard.

In a positive change from the past, 9 out of 10 of our participants shared their avalanche or near miss with others, immediately, or within a few weeks of the event. This sharing denotes a possible change from communication cultures of the past, where accidents were not discussed and debriefed, and where being in an accident was considered shameful, to a culture of communication and empathy, see Krause (2013). By sharing their experience, backcountry travelers give the broader community a more informed perspective about avalanche risk and also have a support network for coping with their trauma. The sharing of accidents and near misses by survivors is also an acknowledgement that backcountry skiing and riding is dangerous, and that it has inherent risks. When we share our experiences, we share

information useful for navigating cognitive bias as it relates to avalanche risk, both in the short term at the slope or regional scale, and in the long term as a reflexive exercise on why we risk our lives to recreate in the backcountry.

This sharing of information is exactly the cognitive work that Maguire and Percival (2018) suggest sets professional teams apart in their avalanche risk assessment from recreationalists, their so called sensemaking of the avalanche hazard. For Maguire, who qualitatively measured how expert practitioners at a Canadian ski area employed cognitive work to manage avalanche risk, the strength of the forecasting team was hidden in the organization's explicit protocols, avalanche risk assessment required cognitive input and activity across the entire operational season, and avalanche risk assessment was an inherently distributed cognitive task across individuals, teams, and the snow industry.

One obvious advantage of working on a forecasting team at a ski area is the existence of specific protocols for managing avalanche risk. This is where Statham's Conceptual Model has perhaps been most helpful and certainly most widely adapted. Of course, an institution likely has a different and lower risk tolerance than an individual, driven perhaps by the concerns of legal liability but complicated by a need to keep as much ski terrain or industrial infrastructure open as possible for clients or participants. Such protocols relate well to Atkins's ideas about strategic mindset.

Even so, individuals and small groups non-commercially recreating in the background do not operate with a playbook of specific protocols. As our recent work (2024) suggests, backcountry users are skiing and riding because they like the movement of flowing downhill in wild, natural settings, and because they like doing so in small groups of like-minded participants. Although they are not risk averse, backcountry recreators are skiing and riding in avalanche terrain not out of an inherent risk tolerance, but instead from a love of being in the mountains practicing their chosen sport.

When we recreate, we make sense of avalanche risk through any number of cognitive filters, including implicit biases. Probably the most challenging tension for the backcountry decision maker is balancing their love of skiing and riding with the inherent and possibly lethal consequence of an avalanche. We are literally doing something that can kill us. Without the existing protocols of the professional organization, one effective way for tempering our desire to ski with the consequence of an avalanche is to enter and travel in areas with avalanche risk with a mentor.

The idea of mentoring as an experiential educational and authentic learning practice is an old

one. For anything that requires skill or technique, apprentices have long worked with the journey-person or master, slowly gaining skills and experience. So too in the avalanche world, as Latosuo and Johnston-Bloom (2018) relay, where the relatively small network of membership suggests that the world of avalanche professionals in the U.S., although certainly not insular, is dependent on relatively few experts. Latosuo found that professional relevancy, personal connection, and initiation of the relationship by the mentor were central factors for how incoming professionals gained access to mentors, and that mentees highly valued the experience and later mentored aspirant snow professionals. Dassler et al. (2024) concur, suggesting that mentoring is one of the most effective forms of education.

5. CONCLUSION

As our study suggests, exposure to avalanche risk is the single largest factor in determining who gets caught in one. As if they intuitively knew this, the approximately 30% of our surveyed group who identified as advanced and expert participants almost always practiced with and carried their companion rescue equipment, embracing the concept that avalanche skills are perishable and that avalanche risk is best managed through continuous learning.

For recreationists, like many in our study, finding a more experienced partner, regularly practicing with companion rescue equipment, touring and digging in the snowpack through the course of the winter season, are key steps toward limiting our tendencies toward cognitive biases and pitfalls when making decisions in avalanche terrain. Likewise, we as practioners and educators need to continue to acknowledge that avalanche skills are perishable and that our human factor is best tempered by continuous learning in authentic situations.

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