Heuristic Traps in Recreational Avalanche Accidents: Evidence and Implications

by Ian McCammon

Authors note: This article extends the findings I presented at the 2002 ISSW in Penticton, BC. A full version of the article, including a description of the statistical methods used, appeared in the Avalanche Review (Vol. 22, nos. 2 & 3). You can download the two-part article at www.snowpit.com.

Several years ago, my buddy Steve died in an avalanche. It was a stormy day and the avalanche danger was high, but Steve and his partners felt that by choosing a familiar route and carefully managing their exposure, they could stay out of trouble. After all, they were experienced backcountry skiers with avalanche training. Steve, the most skilled of the group, had just visited the area less than a week before.

Two hours into their tour, they met another party of skiers headed for the same pass and the low-angle slopes on the far side. They briefly discussed the avalanche conditions, and agreed that prudent route selection was the key to safety that day. But ten minutes later, as Steve's group broke trail across a shallow, treed slope, they triggered an avalanche that swept down on them from above. The avalanche caught all three skiers, seriously injuring one man and completely burying Steve. The other party witnessed the accident and came to the rescue, but by the time they dug Steve out, he was dead.

In the aftermath of the accident, some people felt that Steve died because he took foolish risks that day. Traveling in avalanche terrain during high hazard, they said, was reckless. They believed Steve's group had ignored obvious signs of danger, and that they were tempting fate by crossing under an avalanche path in such conditions. The explanation sounded reasonable.

But it didn't match what I knew about Steve. Weeks earlier, I had shared a lift ride with him at a local ski hill, and we had reminisced about our climbing adventures years before. We laughed about how Steve used to love leading thin, difficult routes, often high above his protection. But things were different now, he said. He told me about his wife and his beautiful four-year-old daughter, and how his days of being reckless were over, and how the time for raising his family had begun. He still loved to ski and climb, he said, but now it was more about enjoying the outdoors and coming home afterwards than about taking risks. When he died, it was on a popular route in familiar terrain, on a slope traversed by dozens of people every season, in a place that he believed was safe.

As sad as this accident was, the real tragedy is that similar stories unfold in accident after accident, year after year. An experienced party, often with avalanche training, makes a crucial decision to descend, cross, or highmark a slope they believe is safe. And then they trigger an avalanche that buries one or more of them. In hindsight, the danger was often obvious before these accidents happened, and so people struggle to explain how intelligent people with avalanche training could have seen the hazard, looked straight at it, and behaved as if it wasn't there.

Heuristic traps in avalanche accidents

So how do people come to believe that a slope is safe, even when they are faced with likely evidence that it isn't? One possible explanation is that people are misled by unconscious heuristics, or rules of thumb, that guide most of our decisions in everyday life.[1] Such heuristics work well for dealing with routine risks such as driving, using crosswalks, or avoiding social embarrassment. But as we'll see, avalanches present a unique hazard that renders some of our heuristics irrelevant, and in some cases dangerously misleading. When a rule of thumb gives us a grossly inaccurate perception of a hazard, we fall into what is known as a heuristic trap.

Six heuristics in particular are recognized as being widely used in our daily decisions: familiarity, consistency, acceptance, the expert halo, social facilitation and scarcity.[2] Because these heuristics work so well and because we've used them for much of our lives, we are largely unaware of using them, even when we are making critical decisions. Such conditions are fertile ground for heuristic traps.

To study the possible influence of these six heuristic traps in avalanche accidents, I reviewed 715 recreational accidents that took place in the United States between 1972 and 2003. Data for the study came from records maintained by the Colorado Avalanche Information Center, published accounts in the *Snowy Torrents* (Williams and Armstrong, 1984; Logan and Atkins, 1996), the Westwide Avalanche Network, the Cyberspace Snow and Avalanche Center, avalanche forecast center annual reports, and various Internet and newspaper resources.

We will see that there is good evidence that many avalanche victims fell prey to one or more heuristic traps. But because this study is based on accident data, it can only demonstrate correlations between victims' behavior and the presence of heuristic trap cues.

Without doing controlled experiments on people's behavior in avalanche terrain (which would be problematic, to say the least), it is not possible to conclusively establish causation of accidents by heuristics traps. Thus, the conclusions of this study should be viewed as preliminary – other causative factors may be at work. Nevertheless, we will see that experimental results from other fields of human behavior support many of the findings.

Evaluating decisions by avalanche victims

If avalanche victims were in fact influenced by heuristic traps, we would expect to see the evidence in their decisions. Specifically, when trap cues were present immediately prior to the accident, susceptible victims would be less objective about the avalanche hazard and would tend to expose themselves to more hazard than they would when the trap cues were absent. In other words, in accidents where victims fell prey to heuristic traps, the presence of heuristic trap cues would correlate with greater exposure to avalanche hazard.

To approximate the objective hazard faced by each party prior to the accident, I computed an *exposure score* that was a linear combination of seven easily recognized indicators of avalanche hazard (Table 1). To minimize reporting biases, I chose indicators that would have been readily apparent not only to the victims, but also to any witnesses, rescue parties or investigators.

The distribution of exposure scores shows that most victims proceeded into the avalanche path in the face of ample evidence of danger (Figure 1). Almost three-quarters of all accidents occurred when there were three or more obvious indicators of the hazard. This finding is consistent with the frequently-made observation that most avalanche victims appear to have ignored obvious signs of instability (Fesler, 1980; Smutek, 1980; Jamieson and Geldsetzer, 1996; Atkins, 2000; Tremper, 2001). Importantly, there were no cases in the data set where all of the hazard indicators were known to be absent.

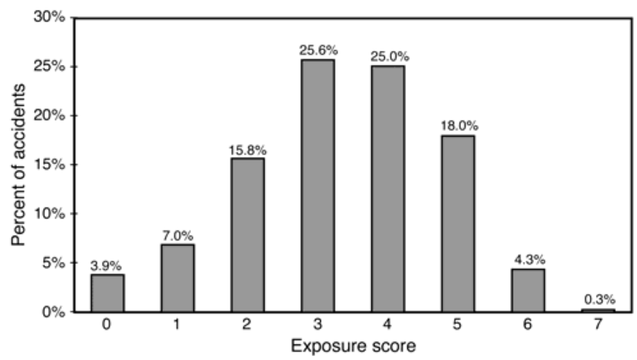

Figure 1. Exposure score frequencies for all accidents in this study, including those where little information was available (N = 715).

Indicator	*Description*	*Frequency*
Obvious path	Distinct start zone, path, runout, trim lines or a known avalanche path.	82%
Recent loading	Loading by snowfall > 15 cm and/or wind in the last 48 hours.	66%
Terrain trap	Obvious terrain features such as cliffs, gullies or dense trees that increased the severity of the slide.	58%
Posted hazard	Considerable, high or extreme hazard posted for the region.	55%
Recent avalanches	In the immediate area, within the last 48 hours.	35%
Thaw instability	Above-freezing air temperatures or rain at the time of the incident.	20%
Instability signs	Collapsing, cracking, hollow sounds or low stability test scores noted by the victims or the rescue party.	17%

Table 1. Hazard indicators used in this study. Frequency column denotes the percentage of all accidents where the indicator was present (N=715).

The blatancy of the hazard in avalanche accidents would be understandable if most victims had little understanding of avalanches. Unfortunately, this does not seem to be the case. When accidents parties are categorized by the training level of the most skilled person in the party (Table 2), we find that almost half of the parties contained at least one person (often the leader) who had formal avalanche training and knew not only how to recognize the hazard, but also how to avoid or mitigate it. Almost two thirds of the parties were aware of the avalanche hazard, and still proceeded into the path anyway. Even more telling is the fact that exposure scores did not significantly decrease with training.[3] Thus, all four levels of training appeared potentially susceptible to heuristic traps.

Training	*Description*	*Freq.*	*Mean age*
None	No training; displayed no awareness of the avalanche hazard.	34%	24.3
Aware	General awareness of the avalanche hazard; took no precautions prior to the accident.	24%	30.1
Basic	Formal avalanche training; consciously took group management precautions prior to the accident.	28%	30.9
Adv.	Extensive formal training; displayed ongoing avalanche and terrain awareness and risk management. Performed meaningful snow stability tests.	15%	33.5

Table 2. Training categories used in this study. Frequency denotes the percentage of accidents where training was known or could be reliably inferred (N = 484).

A number of investigators have suggested that party size may have played a role in decisions leading up to avalanche accidents. A "risky shift," or the tendency of larger groups to take more risk, has been discussed frequently in the literature. As shown in Figure 2, there is a significant variation in exposure score by party size. It appears that people traveling alone and people traveling in parties of six to ten exposed themselves to significantly more hazard than people traveling in parties of four and more than ten people.

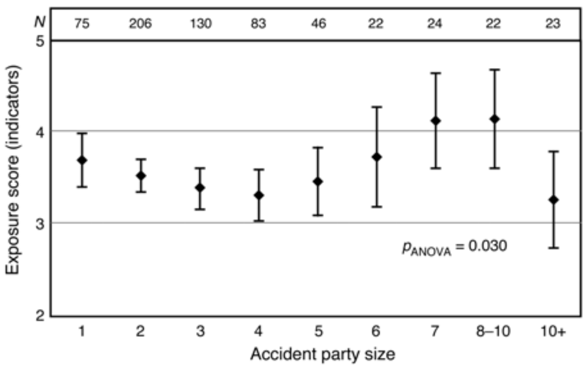

Figure 2. Exposure score variation by accident party size. Mean values and 95% confidence intervals are shown. Parties of 3–5 people and parties of more than 10 exposed themselves to the fewest number of hazard indicators prior to the accident (N = 631).

So far, we've seen that many avalanche victims appeared to ignore obvious signs of avalanche danger, regardless of their level of training. We've also seen that party size correlates with different degrees of exposure to avalanche hazard at the time of the accident. In the next six sections, we'll review each of the six heuristic traps, and examine how cues for these traps correlate with greater exposure by training level and party size. In other words, we'll look at how each trap may have influenced these victims, and why these traps may have been difficult for some parties to avoid. Next, we'll look at the possible cumulative effects of heuristics traps, and which groups were most susceptible. Finally, we'll conclude by examining what all this might mean for avalanche education.

Trap #1: Familiarity

The familiarity heuristic relies on our past actions to guide our behavior in familiar settings. Rather than go through the trouble of figuring out what is appropriate every time, we simply behave as we have before in that setting.[4] Most of the time, the familiarity heuristic is reliable. But when the hazard changes but the setting remains familiar, this rule of thumb can become a trap.

To determine if there was evidence of the familiarity trap in avalanche accidents, I compared exposure scores of accidents that happened in terrain that was familiar (211 cases) or unfamiliar (56 cases) to the accident party. Taken as a whole, all groups showed a significant increase in exposure scores in familiar terrain. The effect was most pronounced in parties

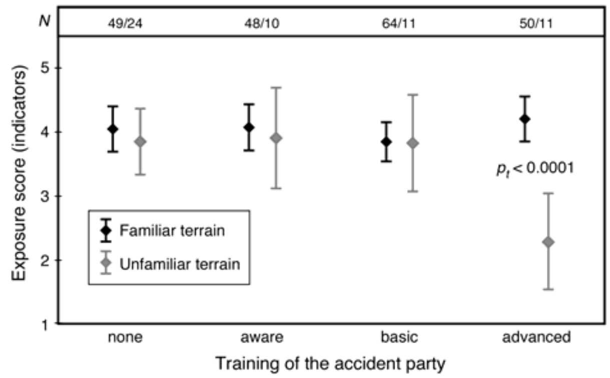

Figure 3. Exposure scores by training in familiar and unfamiliar terrain. Mean values and 95% confidence intervals are shown. Parties with advanced training showed a notable increase in risky decisions when in familiar terrain.

with the highest level of training (Figure 3), who exposed themselves to significantly more hazard indicators in familiar terrain. There was a marginally significant increase in exposure scores for parties of two people.

Apparently, there is a tendency among highly trained accident parties to make riskier decisions in familiar terrain than they do in unfamiliar terrain. Certainly, an intimate knowledge of terrain features, local avalanche history, snowpack structure, or the effects of skier stabilization might have contributed to this tendency. But given the large number of accidents that happened in familiar terrain, it appears that these parties greatly overestimated the degree to which familiar slopes were safer. Remarkably, parties with advanced training that were traveling in familiar terrain exposed their parties to about the same hazards as parties with little or no training. In some respects, familiarity seems to have negated some of the benefits of avalanche training.

Trap #2: Consistency

Once we have made an initial decision about something, subsequent decisions are much easier if we simply maintain consistency with that first decision. This strategy, known as the consistency heuristic, saves us time because we don't need to sift through all the relevant information with each new development. Instead, we just stick to our original assumptions about the situation.[5] Most of the time, the consistency heuristic is reliable, but it becomes a trap when our desire to be consistent overrules critical new information about an impending hazard.

To determine if there was evidence of the consistency trap in avalanche accidents, I compared exposure scores of accident parties that had either high or low commitment to entering the path that eventually avalanched. Highly committed groups had a stated goal that they were actively pursuing or a goal they were motivated to achieve because of approaching darkness, timing or other constraints (253 cases). Groups with low commitment were not motivated to achieve a specific goal; the accident typically occurred during the course of routine recreational activities (138 cases).

Taken as a whole, exposure scores of all groups showed a significant increase when commitment of the party was high. Among different training levels, the effect was marginally significant for parties with basic and advanced training. Among different party sizes, the effect was marginally significant for parties of three people and significant for parties greater than four people. One might argue that any increase in exposure score is simply due to the fact that accident parties were more likely to commit to skiing or highmarking a slope when there was new snow, and thus conditions were more hazardous. However, a comparison of avalanche hazard ratings between high-commitment and low-commitment groups showed no correlation.[6] Thus, it appears that accident parties who felt highly committed to enter an avalanche path did in fact take more risks than parties who were less committed. This finding is consistent with the observations of other investigators, most notably Fredston and Fesler (1994) and Tremper (2001).

Trap #3: Acceptance

The acceptance heuristic is the tendency to engage in activities that we think will get us noticed or accepted by people we like or respect, or by people who we want to like or respect us. We are socialized to this heuristic from a very young age, and because we are so vulnerable to it, it's no surprise that it figures prominently among the heuristic traps embedded in advertising messages.

One of the more familiar forms of this heuristic is gender acceptance, or engaging in activities that we believe will get us accepted (or at least noticed) by the opposite sex. For men, this heuristic often manifests itself in certain types of risk-taking behavior, particularly during adolescent and early adult years. Various studies have established that under certain circumstances, men in the presence of female peers will behave more competitively, aggressively, or engage in riskier behaviors.

To see if the gender acceptance heuristic may have played a role in avalanche accidents, I compared exposure scores from accidents involving mixed-gender parties (109 cases) with those of all-male parties (371 cases). Across all groups, accident parties that included women had a significantly higher exposure score. This difference in exposure score did not vary by group size, but there were notable differences by level of training. Parties with awareness of the avalanche hazard but no formal training (the "aware" training category described in part 1 of this article) showed a significant increase in exposure scores when women were present.

The increase in the exposure score of accident parties that included women does not appear to be a result of those women taking more risks. Of the 1355 individuals present in avalanche accident parties during the study period, females had a slightly lower chance of being caught in avalanches then males. Furthermore, as shown in Figure 4, women appeared to avoid participating in parties where they had the highest probability of being caught.

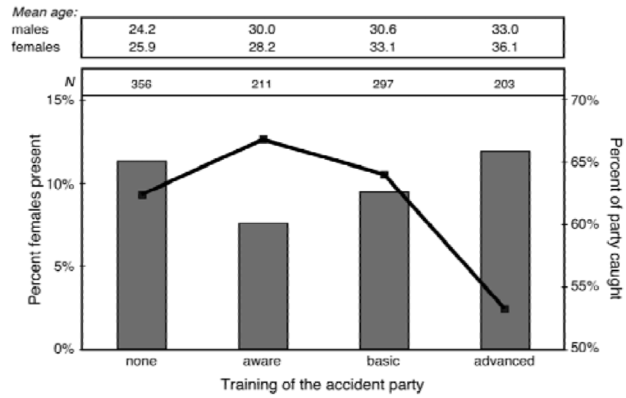

Figure 4. Percentage of females present in accident parties (columns) and the average percent of each party caught (line graph). Women appeared to avoid those groups where they had the highest chances of being caught.

The increased exposure of mixed-gender accident parties may well have been due to reliance on the gender acceptance heuristic by the male party members. In other words, males may have been more willing to expose themselves (and other party members) to greater avalanche hazard when there were women in the group because such behavior was viewed by the men as being more likely to gain the respect or acceptance of the women in their party. Certainly, this behavior matches conventional wisdom regarding the conduct of some avalanche victims, as discussed by Fredston, Fesler and Tremper (1994) and Tremper (2001, p. 226). It is also consistent with recent findings on the behavior of men in the presence of women (see, for example, Roney, et al 2003).

Trap #4: The Expert Halo

In many recreational accident parties, there is an informal leader who, for various reasons, ends up making critical decisions for the party. Sometimes their leadership is based on knowledge and experience in avalanche terrain; sometimes it is based on simply being older, a better rider, or more assertive than other group members. Such situations are fertile ground for the expert halo heuristic, where an overall positive impression of the leader within the party leads them to ascribe avalanche skills to that person that they may not have.

To see if there was evidence of the expert halo heuristic in recreational avalanche accidents, I compared the exposure scores of parties that had a clear, identifiable leader (133 cases) with the exposure scores of parties that had no identifiable leader or the leadership was unclear (465 cases). Across all groups, parties with an identifiable leader had a significantly higher exposure score, but the actual differences depended greatly on the level of training of the leader.

As shown in Figure 5, the difference in exposure score was quite pronounced for those parties who were led by someone with minimal or no avalanche skills. What is surprising about this trend is that untrained parties with no leader (who presumably made decisions by some type of consensus process) exposed themselves to less hazard than they would have if they were relying on an unskilled leader. In other words, unskilled parties seemed to attribute more avalanche knowledge to their leader than to themselves, even when that leader had no such knowledge.

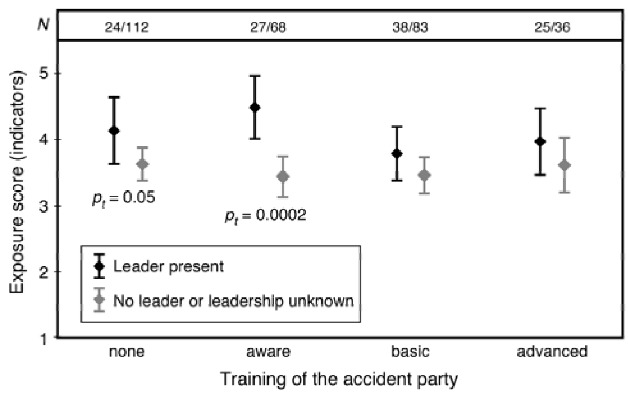

Figure 5. Variation of exposure scores by training and leadership. Leaders with little or no avalanche training appeared to make worse decisions than did similar groups without leaders.

Further evidence of the expert halo heuristic appears when we look at exposure scores by group size. As shown in Figure 6, leaders appeared to make significantly riskier decisions as the group size increased. Such results are consistent with the classic research in conformity, which has shown that pressures to conform in a group increase most significantly when there are majorities of two to four people (Asch, 1951; Plous, 1993).

This data suggests that the expert halo heuristic may have played a role in decisions leading up to avalanche accidents, particularly in large groups and in groups lead by individuals with little avalanche training. In general, it appears that groups were often better off utilizing a consensus decision process rather than relying on the decisions of a perceived "expert," particularly when that leader had poor avalanche skills. As they say, many heads are better than one. Leaders with avalanche training, however, did not make decisions that were significantly worse than those made by trained groups through a consensus process, a result that suggests that leadership by a well-trained individual will result, as we would expect, in more prudent behavior by the party in avalanche terrain.

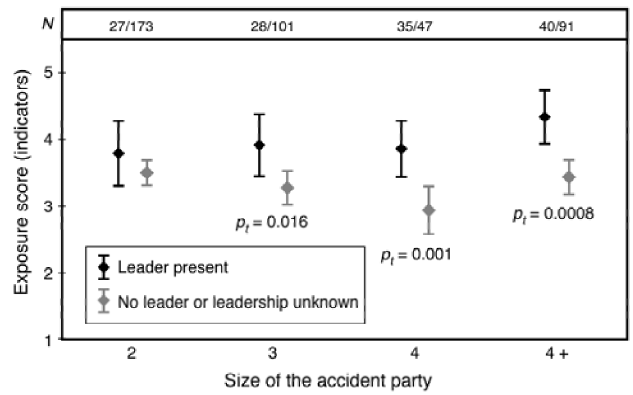

Figure 6. Variation of exposure scores by group size and leadership. Decisions by leaders in recreational accident parties appeared to get worse as group size increased, compared to the no leader condition.

Trap #5: Social Facilitation

Social facilitation is a decisional heuristic where the presence of other people enhances or attenuates risk-taking by a subject, depending on the subject's confidence in their risk taking skills.[7] In other words, when a person or group is confident in their skills, they will tend to take more risks using those skills when other people are present than they would when others are absent. In contrast, when a person or group isn't confident in their skills, they will tend to take less risk with those skills when other people are around. A practical example is the well-known tendency for the best moguls to form directly under ski lifts; good skiers actually ski better when they think other people are be watching.

To see if the social facilitation heuristic may have played a role in avalanche accidents, I compared exposure scores for parties that had met other people prior to the accident (211 cases) with exposure scores for parties that had not met anyone (97 cases). Overall, parties that had met others exposed themselves to significantly more hazard indicators than parties who had met no one. For accidents where the group size was known, the difference was marginally significant for parties of three people and parties of four people.

In accidents where the level of avalanche training was known, the difference in exposure scores was striking. As shown in Figure 7, groups with no formal training ("none" and "aware" categories) showed a marginally significant *decrease* in exposure score in the presence of others. But groups with formal training ("basic" and "advanced" categories) showed a significant *increase* in exposure scores in the presence of others. In other words, parties with no formal avalanche training took fewer risks after meeting other people than did similar groups after meeting no one. But parties with formal avalanche training took substantially more risks after meeting others. These results mirror the behavior of individuals who are utilizing the social facilitation heuristic (Plantania and Moran, 2001), suggesting that it may have played a key role in certain avalanche accidents.

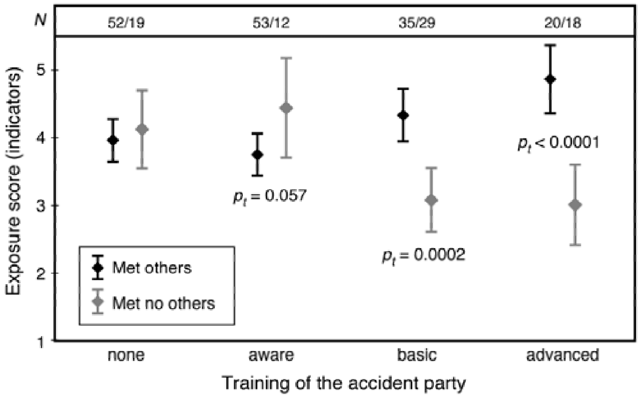

Figure 7. Exposure scores by training for accident parties that did and did not meet others prior to the accident. The bidirectional variation in mean scores is strong evidence of social facilitation effects.

It is worth noting that areas where avalanche victims met others prior to the accident were probably popular, frequently-visited areas. Slopes in these areas would have received more traffic and may have been stabilized to some degree by heavy usage. Thus it seems that the social facilitation heuristic may have some basis in fact – areas where you are more likely to meet others may in fact be safer than areas where people rarely travel. But given the fact that a majority of accidents (at least 63%) occur in well-traveled areas, it is clear that such areas are not categorically safe. Like other heuristic traps, social facilitation appears to work often enough that it lulls its victims into feeling safe, even when the avalanche danger is obvious.

In the accident described in the introduction, Steve's well-trained group met another party before proceeding onto a slope that was normally heavily skied, but was now a newly-loaded avalanche path. Perhaps the presence of the other party influenced their decision through the social facilitation trap, perhaps not. But the accident illustrates the hazards inherent in assuming that well-traveled areas with other people present are safe from avalanches.

Trap #6: Scarcity

The scarcity heuristic is the tendency to value resources or opportunities in proportion to the chance that you may lose them, especially to a competitor (Cialdini, 2001). Those familiar with the "powder fever" that descends on recreationists after a big winter storm have seen this heuristic in action, as individuals take seemingly disproportionate risks to be the first to access untracked snow.

To see if the scarcity heuristic may have played a role in avalanche accidents, I compared exposure scores of parties that had met other people prior to the accident when the slope they were headed for was already tracked (180 cases) to similar groups headed to untracked slopes (31 cases). Overall, parties that had met others and were headed to untracked slopes showed a significantly higher tendency to ignore obvious signs of hazard than parties headed to tracked slopes. The difference was most pronounced (marginally significant) among groups of 3–4 people. Importantly, there was no measurable difference in victims' behavior regarding tracks on the slope when accident parties met no one prior to the accident. This suggests that the presence of others may have played a key role in how avalanche victims perceived the stability of untracked slopes.

It is important to note that when scarcity cues were present, the posted avalanche hazard was, on average, significantly higher than when cues were absent. Thus, the scarcity heuristic works exactly contrary to personal safety; it becomes a more tempting decision-making trap as the avalanche hazard rises.

Sensitivity to Heuristic Traps

So far, we've looked at evidence that six heuristic traps may have contributed to decision errors in avalanche accidents. We've seen that the presence of cues for each trap correlates with different levels of hazard exposure depending on group size and training levels. Now, let's look at the possible cumulative effects[8] of such cues, and examine the preliminary evidence that some groups are more susceptible to heuristic traps than others.

Depending on the particular trap cue, the accident party size, and the level of training of the party, different cues appeared to elicit different hazard exposure behaviors in avalanche victims. The table portions of Figures 8 and 9 summarize the trap cues that appeared to affect each group at the 90% (marginally significant) and 95% (significant) levels. In many cases, trap cues correlated with an increased average hazard exposure by the accident party, a tendency which is denoted by a plus (+) symbol in the table entry. The single case of decreased average hazard exposure in the presence of a trap cue (social facilitation in groups with avalanche awareness but no formal training) is denoted by a minus (–) symbol in the table entry.

The degree to which mean exposure scores of the various group appear to have been cumulatively shifted by the presence of trap cues is shown in the graph portions of Figures 8 and 9. In Figure 8, we see that parties of one or two people appear to be relatively immune to the six heuristic traps, while parties of three or four people appear to be sensitive to expert halo and social facilitation traps. Larger parties (five or more people) appeared to be particularly susceptible to consistency and expert halo traps. It is interesting that larger groups seemed more prone to flawed decision making based on their goals or the choices of a leader, even when that leader had little training and made poor choices. There is safety in

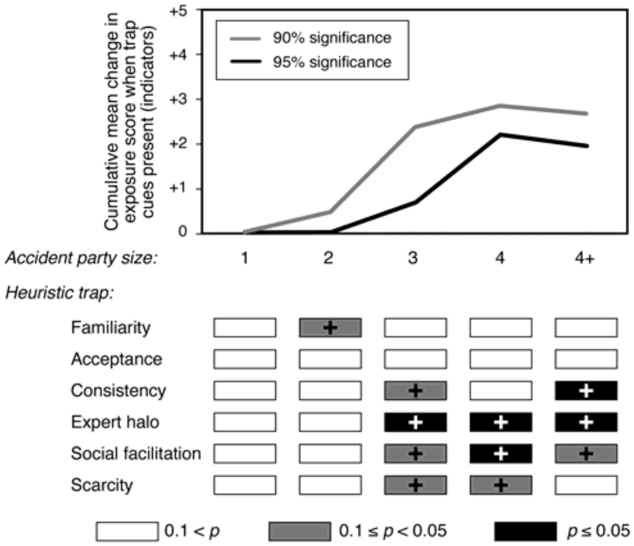

Figure 8. Cumulative mean changes in exposure scores for various group sizes when heuristic trap cues were present. The apparent influence of each trap varies, but overall sensitivity to traps appears to generally increase with group size.

numbers in avalanche terrain, it seems, but only when a group has flexible goals and is lead by an experienced and knowledgeable leader. We saw in Figure 2 that there is evidence of a risky shift among large parties involved in avalanche accidents. The results shown in Figure 8 suggest that sensitivity to heuristic traps may play an important role in that risky shift.

In Figure 9, we see how heuristic trap cues may have affected parties with different levels of avalanche training. Parties who had no training appeared to have little sensitivity to heuristic trap cues, save for their reliance on the "expert" member of their party. Such a low sensitivity to heuristic traps isn't surprising for these victims, since they had no hazard recognition or mitigation skills they could choose to use or not use based on their perception of avalanche conditions.

Parties with a simple awareness of the hazard but no formal training appeared sensitive to the expert halo trap and the gender acceptance trap when their parties contained women. It appears that these parties valued decisions by more experienced members and may have been concerned about impressing the female members of the party. These parties also showed a slight tendency to attenuate risk taking in the presence of others, perhaps because they lacked confidence in their mitigation skills.

Victims with basic avalanche training (the equivalent of a two-day recreational avalanche course) showed an overall decreased sensitivity to heuristic cues, but seemed to overestimate their ability to mitigate avalanche hazard in the presence of others (the social facilitation trap). It is interesting that sensitivity to heuristic traps appears to go down slightly with the advent of formal training – perhaps avalanche education has the effect of re-focusing people's attention on avalanche conditions rather than on social cues.

Victims with advanced avalanche training showed a disturbing tendency to place a lot of faith in the cues of familiarity and social facilitation. Of the six heuristic traps we have looked at, these two are the only ones where heuristic cues may in fact correlate with slightly safer avalanche conditions. What is most striking about this group is the degree to which they apparently relied on these two heuristics. In the presence of familiarity and social facilitation cues, these victims exposed their group to, on average, *three to four more obvious indicators than when these cues were absent*. This suggests that these cues may have represented informal rules of thumb for recreational victims with higher levels avalanche training, even in the face of evidence that the cues were grossly misleading[9].

The overall trend in the graph of Figure 9 implies a disquieting learning curve among avalanche victims. In the early stages of avalanche knowledge and experience, social cues seem to play an important role in determining when a slope is safe. As knowledge and experience grow, decisional heuristics appear to shift to the perceived safety of familiar terrain and overconfidence in one's abilities to mitigate or manage the avalanche hazard. If the 504 deaths represented in Figures 8 and 9 tell us anything, it is that the six heuristic cues have the power to lure almost anyone into thinking an avalanche slope is safe.

There also appears to be a cumulative effect of heuristic trap cues on exposure score. In other words, the more heuristic trap cues that were present prior to an accident, the more hazard exposure the victims appeared willing to accept. Table 3 shows the results

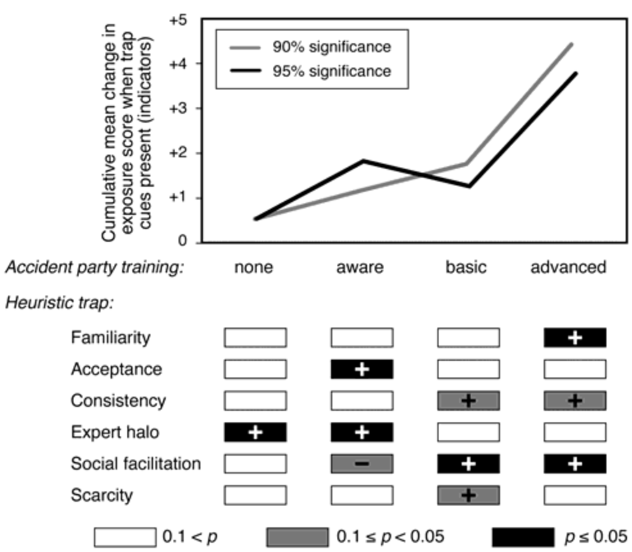

Figure 9. Cumulative mean changes in exposure scores for various training levels when heuristic trap cues were present. The graph suggests a learning process that moves from a flawed dependence on others to overconfidence in mitigation skills and local knowledge.

Training	Spearman correlation	probability	N
None	0.29	< 0.001	164
Aware	0.34	< 0.001	114
Basic	0.35	< 0.001	134
Adv	0.56	< 0.001	72
All	0.42	< 0.0001	715

Table 3. Correlations between the number of heuristic trap cues present in avalanche accidents and exposure scores of the parties involved. Correlations were highly significant, which is strong evidence for the influence of heuristic trap cues on decisions that lead to accidents.

of a Spearman tied-rank correlation between the number of heuristic cues[10] and the exposure score for different training levels. The strength of the correlation, or the degree to which heuristic cues appear to influence hazard exposure, grows with training, a result that is consistent with Figure 9. It is important to note that well-documented accidents tend to have more complete reporting of both exposure factors and trap cues, possibly contributing to the overall correlation effect. Nevertheless, the increasing correlation with training and the high significance of that correlation suggests that the relationship between the choices of avalanche victims and the presence of heuristic trap cues is more than a statistical artifact.

At the start of this article, I described an avalanche that killed my friend Steve, and the puzzle that it presented: How could a skilled, intelligent person with every reason to live see obvious evidence that a slope was dangerous, and then act as if the slope was safe? For a possible answer, let's revisit the accident in light of the six heuristic traps we've examined.

Despite high avalanche hazard, Steve and his two friends had chosen a clear objective (a consistency cue) in familiar terrain (familiarity cue): a prominent pass that would lead to some low-angle powder skiing. Steve was viewed by his friends as being more knowledgeable about the route and avalanches in general (an expert halo cue). As their group of three neared the pass, they met another party (a social facilitation cue and perhaps a scarcity cue) and discussed the widespread avalanche hazard. Thus, at least four of the six heuristic trap cues were present when Steve's group finally evaluated their route across the slope that eventually avalanched: familiarity, consistency, the expert halo, social facilitation and possibly scarcity. In Figure 8, we see that parties of three appear to be particularly susceptible to four of these trap cues. In Figure 9, we see that familiarity and social facilitation cues correlate with a dramatic increase in exposure score for trained groups such as Steve's. Sadly, the accident that took Steve's life does not appear all that unusual. We'll never know for sure, but because the group was surrounded by obvious signs of danger on a high hazard day, it seems very likely that Steve's real killer wasn't the avalanche that swept down on him and his friends, but the compelling heuristic traps that deceived him into thinking that the slope was safe.

Implications for Avalanche Education

Despite the preliminary nature of this study's findings, there are a number of implications for avalanche education that are worth considering:

It appears that formal avalanche education did not make victims in this study less likely to be in accidents. Across all levels of avalanche training, overall exposure scores remained about the same, suggesting that these individuals were in the business of trading off the risks of being in avalanche terrain with the perceived benefits of engaging in their chosen activity. In other words, these victims were apparently using their training to access avalanche terrain during dangerous conditions so they could more fully enjoy their sports. For these people, courses aimed avoiding avalanche hazard would have little utility, and would probably not affect fatality rates in this population significantly. This group would benefit most from courses that provided risk management tools for balancing hazard exposure with recreational objectives. A sobering implication is that such courses might be more successful at extending students' mobility in avalanche terrain than at reducing the total number of accidents.

Formal avalanche training did not appear to equip these victims with effective tools for decision making. If these victims had used the knowledge-based decision strategies that are commonly taught in avalanche courses, we would expect very few accidents under such obvious conditions. Instead, we find that even well-trained victims appeared to ignore easily-recognized signs of avalanche hazard. Thus it appears that they were either unwilling or unable to apply what they had learned. Of course, these victims represent a very special group of people: those that were caught in avalanches, and so they may be uniquely prone to poor decisions. But if they were instead typical of many recreationists, their susceptibility to heuristic traps suggests a re-evaluation of how courses prepare students for making decisions in avalanche terrain.

Heuristic traps are attractive because they are fast and convenient for novices, Knowledge-based decision strategies generally are not. The heuristics explored in this article are fast, convenient and most of the time don't result in accidents (i.e. most of the time people don't trigger avalanches). In contrast, knowledge-based decision tools are often slow, tedious and can yield ambiguous results. Given a choice, most of the avalanche victims in this study apparently opted for the quick decision tool, even though it was not universally correct. Thus the challenge for educators is to offer practical alternatives to heuristic traps.

Teaching about human factors alone probably won't significantly reduce avalanche accidents. If trained victims were ignoring such obvious clues as recent avalanching and terrain traps, adding more information to the avalanche curriculum about human psychology is unlikely to change behavior. The problem was not that these victims didn't have enough knowledge to make good decisions; the problem was that they didn't know how to apply the knowledge that they did have.

If the goal of avalanche education is to reduce avalanche deaths, then the challenge to the avalanche educator goes beyond simply imparting information. The challenge is to encode knowledge into simple, easily-applied decision tools that can compete with the heuristic traps described here. Luckily, such tools don't need to be perfect to save lives. They just need to be more accurate than the social cues that most avalanche victims apparently rely on.

Acknowledgements

I'd like to thank Dale Atkins and Knox Williams for granting access to the records of the Colorado Avalanche Information Center. Dale Atkins, Don Sharaf and Allen O'Bannon provided valuable insights during many late-night discussions. And thanks to everybody who bought a copy of the *Snow and Avalanche Field Notebook* by SnowPit Technologies: you helped support this research.

Endnotes

1 Despite some bad press in the early days of decision science, heuristic reasoning has emerged as the most likely theory explaining our ability to make good decisions when we lack time or expertise. Gigerenzer et al (1999) and Chaiken and Trope (1999) give excellent reviews of modern research in heuristics.

2 Because they take place mostly at an unconscious level, the six heuristics traps studied here form the basis of many advertising messages and induced-compliance processes. They have their roots in well-known principles of social and experimental psychology. Aronson (1999), Pratkanis and Aronson (2000) and Cialdini (2001) provide in-depth, if somewhat disturbing, overviews of these principles.

3 In this article, significant differences are defined as having a 5% or less chance of being due to random variability in the data. Marginally significant differences are defined as having a 10% or less chance of being due to random variation.

4 This heuristic is closely related to the well-known "availability heuristic" originally identified by Amos Tversky and Daniel Kahneman (1974). This heuristic creates a tendency to base our decisions on information that is most easily recalled.

5 The commitment heuristic seems to be a product of at least two psychological principles. The first is cognitive dissonance, which embodies our desire to be and appear consistent with our words, beliefs, attitudes and deeds. The second is cognitive conservatism, which is our tendency to preserve our preexisting knowledge, beliefs and hypotheses. See Plous (1993), Aronson (1999) or Hastie and Dawes (2001) for detailed discussions of these principles.

6 The Kruskal-Wallis or *H*-test showed no significant difference in hazard ratings between these groups.

7 The social facilitation heuristic appears to require only that other people be present or be nearby. Whether or not the present others are perceived to have better or worse skills or whether they are in a judging capacity does not appear to affect this heuristic. See Plantania and Moran (2001), or Zajonc and others, (1970) for discussions.

8 This section discusses heuristics traps as if they are independent factors, unless noted in the text. It is quite possible that heuristic traps have combined effects on exposure score that are greater or less than the sum of the effects of each trap. In this case, a six-way (or twelve-way, to account for negative states) factorial analysis of variance would reveal combined effects among the 63 (or 4095) possible combinations. Such analysis was beyond the scope of the rather modest statistical methods used in this study.

9 Sensitivity to these heuristics appears to be linearly independent for victims with advanced avalanche training. A crosswise comparison of exposure scores showed no significant differences in the contribution of either heuristic trap to the overall change in mean exposure score.

10 The number of heuristic cues was summarized as a FACETS score, where the acronym represents each of the heuristic traps (the "T" stands for tracks, as in first; another name for scarcity). The acronym is a useful test for recognizing heuristic traps in the field, and is a valuable teaching metaphor that illustrates how faulty assumptions can dangerously undermine even the deepest knowledge and experience.

References

Aronson, E. 1999. *The Social Animal*, Worth Publishers, New York.

Asch, S. 1951. Effects of group pressure upon the modification and distortion of judgment. In H. Guetzkow (Ed.), *Groups, Leadership and Men*. Pittsburgh, Carnegie Press.

Atkins, D. 2000. Human factors in avalanche accidents, *Proc. Int'l Snow Science Workshop*, Big Sky, MT, Oct. 2000, pp. 46 – 51.

Chaiken, S. and Trope, Y. 1999. *Dual Process Theories in Social Psychology*, Guilford Press, New York.

Cialdini, R. 2001. *Influence: Science and Practice*, Allyn and Bacon, Boston, MA.

Fesler, D. 1980. Decision-making as a function of avalanche accident prevention, *Proc. Avalanche Workshop*, Assoc. Comm. on Geotechnical Research, Nat'l Res. Council of Canada, Tech. Memorandum no. 133, Ottawa, Canada.

Fredston, J., Fesler, D. and Tremper, B. 1994. The human factor – Lessons for avalanche education, *Proc. Int'l Snow Science Workshop*, Snowbird, UT, Oct. 1994, pp. 473–487.

Fredston, J. and Fesler, D. 1994. *Snow Sense: A Guide to Evaluating Snow Avalanche Hazard*, Alaska Mountain Safety Center, Anchorage, AK.

Gigerenzer, et al. (eds).1999. *Simple Heuristics That Make Us Smart*, Oxford University Press, NY.

Hastie, R. and Dawes, R. 2001. *Rational Choice in an Uncertain World: The Psychology of Choice and Decision Making*, Sage Publications, Thousand Oaks, CA.

Jamieson, B. and Geldsetzer, T. 1996. *Avalanche Accidents in Canada, Volume 4: 1984–1996*, Canadian Avalanche Assoc., Revelstoke, BC.

Logan, N. and Atkins, D. 1996. *The Snowy Torrents: Avalanche Accidents in the United States, 1980–86*. Colorado Geological Survey, Spec. Pub. 39, Denver, CO.

Plantania, J. and Moran, G. 2001. Social facilitation as a function of the mere presence of others. *Journal of Social Psychology*, 14(2), pp. 190–197.

Plous, S. 1993. The *Psychology of Judgment and Decision Making*, McGraw-Hill, NY.

Pratkanis, A. and Aronson, E. 2000. *The Age of Propaganda: The Use and Abuse of Persuasion*, W.H. Freeman and Co, New York.

Roney, J., Mahler, S. and Maestripieri, D. 2003. Behavioral and hormonal responses of men to brief interactions with women. *Evolution and Human Behavior*, 24(6), pp. 365–375.

Smutek, R. 1980. Experience and the perception of avalanche hazard, *Proc. Avalanche Workshop*, Assoc. Comm. on Geotechnical Research, Nat'l Res. Council of Canada, Tech. Memorandum no. 133, Ottawa, Canada.

Tremper, B. 2001. *Staying Alive in Avalanche Terrain*, Mountaineers, Seattle, WA.

Tversky, A. and Kahneman, D. 1974. Judgment under uncertainty: Heuristics and biases. *Science*, 211: 453–458.

Williams, K. and Armstrong, B. 1984. *The Snowy Torrents: Avalanche Accidents in the United States 1972–79.* Teton Bookshop Publications, Jackson, WY.

Zajonc, R. and others. 1970. Social facilitation and imitation in group risk-taking. *Journal of Experimental Social Psychology*, Vol. 6, pp. 26–46.