WHAT IS THE RISK THRESHOLD THAT BACKCOUNTRY ENTHUSIASTS ARE WILLING TO ACCEPT AND HOW DOES THEIR PERCEPTION ALIGN WITH THE ACTUAL RISK INVOLVED?

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ABSTRACT: An empirical investigation looked at backcountry enthusiasts’ avalanche danger threshold and what the main factors are that alter that threshold. The study was based on an on-line questionnaire that looked at the responses of 343 individuals. This survey was published through many outlets, which allowed for a very diverse respondent base with a majority of people being skiers from Western North America. The results demonstrated that the presence of an air bag, seeing someone ride down a slope, the familiarity with a slope, or the presence of a guide contributed to a statistically significant increase in the danger threshold of many respondents at the 99% level. The extent of how many people it affected and its impact is analyzed in the study.

KEYWORDS: Decision-making, Human factors, Risk homeostasis, Cost-benefit analysis, Education.

1. INTRODUCTION

On the first clear day after a storm in Hakuba, some friends and I decided to remain at the resort since the avalanche danger was high. Even though the back bowls looked attractive, we all had enough avalanche education to determine that it was not worth taking the chance. As we rode down, we noticed a group of people about to venture on Happo North face. We all agreed that their choice to go there based on the danger was a terrible one. We looked to see what would happen, but we did not want to look to avoid witnessing a burial. In the end, nothing happened. If you ask me, they got lucky. What follows is what surprised me the most. One of my friends who had some avalanche knowledge and initially agreed that it was a terrible decision to head down there on that specific day looked at me and said: “That should have been me riding that line!” At that point, I could not help to wonder why educated people can modify their perception of danger so rapidly.

Over the years, avalanche education has done a great job at offering an easy to understand tool set to help in decision-making for backcountry travel. Following the many avalanche deaths of 2003, a team of researchers developed the Avaluator. Details of this project can be found in Haegeli et al. (2006). It is an easy system developed for recreational avalanche courses in Canada, which consists of a simple checklist to evaluate the avalanche danger rating and then choose an appropriate terrain. More recently, Haegeli et al. (2010) looked at amateur decision-making with and without a decision aid. They found that a simple decision aid could guide people in the right direction towards a more avalanche conscious behavior.

Despite avalanche training, in practice the human factor enters the equation and alters the trained judgment. Atkins (2000) determined that out of 41 avalanche accidents, 34 were due to poor decision-making errors. McCammon (2002) first discussed heuristic traps when he looked at past instances of avalanches and found that factors such as familiarity, social proof, commitment, or scarcity led to poor judgment. Acceptance and expert halo were later introduced in McCammon (2004) and all six are human factors discussed in recreational avalanche training. These studies focused on past occurrences of avalanches and tried to determine what may be the cause after the fact.

One of the theoretical reasons that may explain why people modify their behavior is called risk homeostasis. It is a risk compensating mechanism, where as the potential costs of an accident falls people are willing to take on more risk (Wilde, 1998). Thus, as the damage suffered from getting caught in an avalanche is lowered, people will adapt by exploring riskier terrain to keep their

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death likelihood stable based on their personal risk tolerance (Wilde, 1982). For example, when safety devices in cars such as seatbelts are improved, people tend to drive faster (Janssen, 1994). Therefore, pieces of equipment such as an avalanche airbag pack may make people more willing to go in more dangerous terrain than they typically would.

We would hope that when new safety measures are introduced, people would not increase their exposure and that it would have the effect of lowering deaths. The reality is that risk homeostasis impacts many aspects of our daily lives and can still be seen as "rational."

The purpose of study is to investigate what kind of factors can make people alter their decision to ride a line or not, and which of these is the most significant. The rest of the paper is as follows. Section 2 will present the survey and the participation demographics. Then, section 3 will analyze the survey results pertaining to the danger threshold. Section 4 will consist of the conclusion as well as extensions and policy recommendations.

2. SURVEY DEMOGRAPHICS

A survey was sent out through various avalanche associations and facebook groups. Some examples are the American Institute for Avalanche Research and Education, the Forest Service National Avalanche Center, the Canadian Avalanche Association, Avalanche Canada, Avalanche Quebec, Backcountry Quebec. Participation was encouraged thanks to roadpost.com, who donated a DeLorme inReach SE satellite communication device as well as multiple Powder magazine subscriptions. 509 individuals opened the survey and 406 completed it. Out of the completed surveys three types of responses were rejected. First, we removed 10 reports where the practitioner never used a transceiver and had a maximum danger threshold of 0 in all scenarios since these people would not venture in avalanche terrain. Second, 36 respondents who said that their danger threshold was higher when they forgot their transceiver were rejected. It is assumed that these people must have misread the question, as it is illogical for someone to take on more risk if they forgot their transceiver. Additionally, 17 reports were removed since an airbag/avalung combo led to a lower danger threshold. Again, it is assumed that these individuals misunderstood the question, as a reduction in avalanche danger threshold is illogical in this scenario. Of the 343 remaining responses, the following are some key demographics.

2.1. Gender

57 (16.6%) respondents were female and 286 (83.4%) were male.

2.2. Age

Respondents were 20 to 76 years old with a mean of 42 and a standard deviation of 12.4 years.

2.3. Which sport?

Most respondents were backcountry skiers and account for 254 (74.1%) respondents. Skiing off-piste, snowmobiling, and backcountry snowboarding each had 26 respondents (7.6% each). Snowboarding off-piste and “other” accounted for the 4 and 7 respondents remaining respectively.

2.4. Where?

281 respondents (81.9%) predominantly explore the backcountry in Western North America, 35 (10.2%) in Eastern North America, 18 (5.2%) in Europe and 9 respondents (2.7%) predominantly skied in other regions.

2.5. Avalanche course training and self-evaluated expertise

Avalanche course training consisted of 29 (8.5%) respondents who have never completed any avalanche course, 66 (19.2%) who have completed one recreational avalanche course, 73 (21.3%) who have completed multiple recreational courses, 133 (38.8%) who have completed a professional level avalanche course and 42 (12.2%) who have also completed a ski guides course. Therefore, a little more than half of the respondents have a professional level avalanche course completed. These figures are similar to the numbers found when asked about avalanche expertise. We have 44% self-evaluated experts, 40.8% intermediates, 14.3% beginners and 0.9% with a non-existent avalanche expertise.

2.6. Frequency of carrying transceiver, shovel, probe

The frequencies for transceiver, shovel, probe were similar with about 315 (92%) of the 343 respondents always carrying all three. When looking at the five that never carry a transceiver: one only goes out if the danger is low, one is on snowshoes, one is a snowmobiler that goes out at

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1 The survey questionnaire is available upon request.
moderate hazard or less, one is a skier from Eastern North America and accepts moderate danger, one is a snowboarder from Western North America. The last three are the most worrying, but only represent 1% of the population analyzed.

2.7. Frequency of carrying an airbag or avalung
Most respondents do not carry an airbag or an avalung. For the airbag, 196 (57.1%) respondents never carry one, 41 occasionally (12%), 50 (14.6%) often, and 56 (16.3%) always wear one. Less people use avalungs with 259 (75.5%) respondents who never carry one, 45 (13.1%) occasionally, 21 (6.1%) often, and 18 (5.2%) always carry one.

2.8. Practice using avalanche equipment
Most have answered that they practice using their avalanche equipment. 207 (60.3%) respondents simulate multiple burial scenarios every year, 114 (33.2%) simulate one scenario a year, 13 (3.8%) practiced once when they bought their equipment, and 9 (2.6%) never practiced using their avalanche equipment.

2.9. Deaths
40% of the respondents stated that they lost a friend in an avalanche.

2.10. Human Factors segment
65.9% of the respondents stated that they have read the Powder Magazine segment on Human Factors. Some understanding of the heuristic traps and the human factors at play are expected.

The demographics are interesting to note what type of respondent we attracted in this survey, but it is the answers with regards to the avalanche danger threshold that are the most interesting in this study. For the moment, an analysis of all the respondents together will be done, but with the quantity of respondents it would be interesting to limit the analysis to a group of people based on region, age, gender, sport, use of equipment, a proxy of experience/expertise and to determine what influences most subcategories and what does not.

3. SURVEY RESULTS
A baseline scenario was established and asked respondents to determine their threshold level of danger that they would accept. First, the choice of answers included one of the five hazard classification levels. Second, we mentioned “We will now convert that danger threshold to a scale of zero to 10, zero being absolutely no risk of triggering an avalanche and 10 being absolutely certain to trigger one with a large destructive potential, what level would you be comfortable to go skiing?” After determining the answer for the baseline scenario, then a series of questions were asked always creating small modifications to the baseline scenario and asking what their new danger threshold is on the same 0 to 10 scale with 0.5 increments. The goal is to identify which factors significantly alter the risk threshold compared to their respective baseline. Some of the scenarios will not be analyzed for this short paper, but will be found in a future report.

The propensity of people to take on risks depends on their personality, life experience and lifestyle, age, being part of a group, or having a family (McClung, 2002; Wilde, 2001). Determining the risk aversion or why people have a certain risk tolerance was not the goal of the study. However, to get a sense of the 343 respondents, 29 (8.5%) of the respondents said they would only venture out on the slope if they determined the avalanche hazard to be low, 166 (48.4%) if moderate, 131 (38.2%) if considerable, 15 (4.4%) if high, and 2 (0.6%) if extreme. When asked to convert this threshold on a scale of 0 to 10, the average of all respondents was 4.363.

For all the following analyses you will observe the mean values of all the seven modified scenarios (plus the baseline mean) and the results of t-tests comparing paired means with the baseline scenario. These tests are all statistically significant at the 99% level except the “first and last chance to ride a slope” which is only statistically significant at the 95% level (Tbl. 1).
The first two modified scenarios deal with equipment, the next two deal with observations, the two after that deal with foreign (commitment) versus familiar slope, and the last one deals with the expert halo.

3.1. Impact of removing transceiver

Removing the transceiver created the largest difference in danger threshold of all scenarios. The mean threshold went from 4.2 to 1.7 on 10 as the danger threshold. This reduction can be seen as rational since if you remove the transceiver, you drastically lower the likelihood of being found in time by the rest of the group. Thus, to compensate for this harder search, people will only venture out if the likelihood of getting caught and buried is much lower. Note that 36 of 343 respondents did not alter their danger threshold compared to the baseline. Of the 36, 29 of them were said to always carry a transceiver with only 3 said to never carry a transceiver. Those who did not alter their threshold can simply be seen as not letting their choices to be impacted by equipment.

3.2. Impact of adding an Airbag and Avalung

When looking at all respondents we have a statistically significant increase of 0.262 in danger threshold for people wearing an airbag/avalung. Only 80 of 343 respondents altered their danger threshold by adding an airbag/avalung versus 307 when removing the transceiver. The potential misunderstanding of some that in the baseline scenario the airbag/avalung that they usually use is not available may cause part of the reason many did not alter their threshold.

In aggregate going from 4.363 to 4.625 on the avalanche danger scale although statistically significant can be seen as a slight jump. However, if you factor in that 263 participants did not modify their threshold at all, you can notice that the behavior changed more dramatically for the 80 who are influenced by this piece of equipment. Of the remaining 80, the threshold without an airbag/avalung is 4.831 and with an airbag/avalung is 5.956, which is a 1.125 jump that is statistically significant (t-value = 11.570). Interestingly, of those 80 respondents, 51 never carry an airbag, and 57 never carry an avalung, with only eight and nine saying that they always carry an airbag or avalung respectively. Thus, for those 51+ respondents if they were to win an airbag as a prize or purchase one, we would expect some form of risk compensation to occur. This result differs from Wolken et al. (2014) who were not able to identify the risk compensations effects of the avalanche airbag.

Even if all of the respondents were clear on the equipment available and not available in the baseline and appropriately answered the survey the results are still quite interesting. People who say that having an airbag does not alter human behavior may be right for 77% of the respondents. However, there are still 23% of the respondents who would significantly increase their danger threshold in the presence of an airbag. As Dr. Haegeli suggested for future surveys, it would be important for the user to have a better knowledge of what the run looks like in its entirety because an airbag is truly useful only in certain circumstances. However, as people guessed what the remainder of the terrain looked like there was still an important change in threshold despite this uncertainty.

3.3. Impact of seeing a skier ski down the same slope

The impact of noticing another skier come down a slope had a slightly larger effect on the aggregate threshold than an airbag/avalung. Keep in mind that this example does not modify the danger mitigating equipment available, but is based solely on the perception of a safe slope. In this case, more respondents modified their threshold with 131 out of 343 (38.2%) Out of those 121 increased their threshold and 10 decreased it.

This observation is what motivated us to undertake this study in the first place. We agree that observing a skier trigger an avalanche is a good sign of avalanche danger, but observing only one skier come down a slope and not trigger an avalanche should not necessarily be interpreted as an absence of avalanche danger. There has been a significant amount of new literature on spatial vari-
ability to demonstrate that seeing one skier coming down a slope should not be interpreted as it being safe (for a review see Schweizer et al. 2008).

As McCammon (2002) notes, the social proof heuristic trap tells us that a slope, which has been skied or high marked, is believed to be less likely to avalanche. He notes the very interesting results that in 204 avalanche cases he investigated the slope had tracks on it or nearby and only in 94 cases were there no tracks on the slope or nearby. One of McCammon (2002) study reservations is that his research demonstrates correlation and not necessarily causation. However, in the present study, seeing people alter their danger threshold solely after modifying this factor can be seen as a cause and effect relationship.

3.4. Impact of no avalanche last week with similar conditions

123 respondents modified their threshold (35.9%) which is similar to the previous scenario. 95 respondents increased the threshold and 28 decreased it. Even though, the number is smaller than the one obtained when observing a skier coming down the slope the same day, the idea that people have a tendency to increase their danger threshold a week after observing a skier coming down safely with similar avalanche conditions is concerning. After noticing my friends who thought that they should have been the ones riding a slope on a given “high avalanche danger” day, I was concerned that if similar conditions would occur later in the season that they would go out based on past “lack” of avalanche occurrences. This observation could be tied to the familiarity heuristic which is discussed next, since the more time you spend somewhere the more likely you may start lowering your guard and say: “I never saw that slope avalanche, so I am not too worried”.

3.5. Familiar slope

A familiar slope is the scenario that increased the danger threshold the most of all scenarios. Despite familiarity being a well-known heuristic trap, 123 (36%) respondents increased their danger threshold (28 decreased the threshold). If we focus on the people who increased their threshold the mean difference with the baseline for those people is of 1.2 on 10. It seems to be that people have a sense of security around things that they are used to seeing and tend to lower their guard.

3.6. First and last opportunity

The results here seem to tell a variety of stories, but first the data states that 216 did not modify their threshold compared to the baseline. Out of the 127 respondents who did, 70 increased their threshold and 57 decreased. The decrease of the 57 respondents was large enough (with a 1.7 average on 10), to lower the overall average danger threshold of the respondents compared to the baseline. The underlying reason for this variety of responses is unclear, but perhaps the 57 feared the new location compared to a familiar one. At the same time, the specific average for those 57 individuals for a familiar slope was lower than their baseline average, so we are not quite sure of their rationale.

3.7. Guide

By the demographics of the survey, we understand that we have a fair amount of guides responding to this survey. Despite this fact, 171 had different thresholds, with 118 who increased it compared to the baseline, and 53 who decreased their threshold. Perhaps some of the experienced individuals decrease their threshold in the presence of other guides. 37 of the 53 (70%) of them have completed a professional level avalanche course. Overall, there is still a significant increase in risk taking in the presence of a guide, which may signal some form of expert halo.

3.8. Reservation about results

Surveys are always subject to interpretation or people rushing through, which may lead to some of the unintuitive responses. We also had responses by some participants with reservations. Some would argue that this decision to ride a line or not happens at a subconscious level. Others would debate that not enough information was given to properly assess the danger involved. Some say that answers may be different being in an office in the summer. Last but not least, some do not like transferring the Avalanche Danger Classification from five words to a zero to 10 number. Additionally, some would prefer if the scenarios were separated or used direct questioning such as in Haegeli (2012) and Christie (2012). Having a series of complex examples that are separated has its advantages, but it makes it harder to compare results.

We chose to use a survey that ensured anonymity and enable the changes in scenario to be simple so that some people may answer in a fast way leading to a more accurate subconscious level of
thinking. However, we expect some individuals that are educated on common heuristic traps to take time to answer in a more informed way (i.e. what they should do) rather than how they really would decide outside (i.e. what they would do). Or as Wolken et al. (2014) mention, this may be more of a planning type analysis than an on the slope analysis. If on average there is a significant difference despite this potential informed decision, it tells us that there is still a human factor issue present.

Ideally, we would be able to monitor a group of people with GPS devices on different days and look at how they adapt to different conditions as in Hendrikx et al. (2013) or in Hendrikx and Johnson (2014). However, we have a few reservations about that technique. For one the participants have actively chosen to be followed so this type of person is only a small segment of the population. Second, these people know they are being monitored and this may alter their behavior. Lastly, the people are not facing scenarios where only one factor changed, thus it is harder to isolate their change in behavior. For example, they may simply be ill that day.

The goal here was to measure the change in danger threshold following small modifications. We also wanted a representative anonymous sample of the people heading into avalanche terrain, and we believe this survey succeeded at doing so.

4. CONCLUSION
An observation in the field made us wonder how people can change their behavior so rapidly, and through this study we realized that this incident is not an isolated case. Heuristic traps may not be completely widespread thanks to some form of avalanche education, but they are definitely still present. It would be worth investigating further into why and who have increased their danger threshold. We could look for common factors that characterize these individuals who have a greater tendency to vary their danger threshold and ensure that we find ways to communicate with them in future avalanche education.

An investigation in risk homeostasis to determine what factors may rationally increase risk taking and which should not would be interesting. For example seeing someone come down a particular slope can increase the perception of safety, but should not allow people to increase danger exposure significantly. Additionally, an airbag protects users in certain circumstances, but like a seatbelt it will not save your life all the time. Thus, spatial awareness, familiarity, and the true situations where an airbag can help someone are key topics that should have an increased discussion in avalanche education.

CONFLICT OF INTEREST
No company supported financially or materially the creation of this document. The author only received a few prizes to be given out to promote participation in the survey.

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