UiT The Arctic University of Norway

Department of Psychology

Safety in Avalanche Terrain

A mixed method study on how Norwegian backcountry skiers plan, conduct and evaluate trips

Ingrid Stette Haarberg

Master's thesis in Psychology May 2020

Photo: Audun Hetland

Foreword

First of all I would like to thank my supervisor Audun Hetland for giving me the opportunity to dig deeper into a field I find so interesting and for his much-appreciated guidance and support.

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Audun Hetland

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Abstract

Every year backcountry skiers are victims of avalanches, and human errors are recognized as one of the most important factors in explaining why these accidents happen. We used an embedded mixed method design, in which the qualitative data was given priority, in order to investigate how backcountry skiers plan, conduct and evaluate trips in avalanche terrain. In all, a sample of 23 backcountry skiers in Norway answered a short questionnaire before and after trips during the winter season 2018/19. A subsample of the participants (N = 8) were interviewed during the summer of 2019. The qualitative method had a phenomenological approach that utilized a descriptive design, and a thematic analysis was conducted on the written transcripts. Overall, our findings revealed a gap between what the participants planned to do and what they ended up doing on their trips. Such a gap is likely to be influenced by both external terrain factors regarding avalanche hazard, and by human factors. Knowledge and experience proved to be influential in how the participants planned and conducted trips. Answering questions before and after trips contributed to more reflection and learning from trips, as well as situation awareness while conducting trips in avalanche terrain. Our findings have implications for future risk reduction strategies and avalanche education and training.

Keywords—avalanche safety, human factors, intention-behaviour gap, mixed methods

Sammendrag

Hvert år blir personer som er på skitur i skredterreng drept i snøskred. Menneskelige feil er vurdert som en av de viktigste faktorene som forklarer hvorfor slike ulykker skjer. I vår studie brukte vi en 'embedded mixed' metode for å undersøke hvordan personer planlegger, gjennomfører og evaluerer turer i snøskredterreng. Et utvalg av 23 personer i Norge besvarte et kort spørreskjema før og etter turer gjennom vintersesongen 2018 / 2019. Et underutvalg av deltakerne (N = 8) ble intervjuet i løpet av sommeren 2019. Den kvalitative metoden ble prioritert, og hadde en fenomenologisk tilnærming med et deskriptivt design. Det ble gjennomført en tematisk analyse på de transkriberte intervjuene. Vi avdekket et gap mellom det deltakerne planla å gjøre og det de endte opp med å gjøre på turer i skredterreng. Et slikt avvik skyldes sannsynligvis både ytre faktorer i terrenget som er relatert til snøskredfare, og menneskelige faktorer. Kunnskap og erfaring viste seg å påvirke hvordan deltakerne planla og gjennomførte turer. Det å svare på spørsmål før og etter turer bidro til mer refleksjon og læring fra turene, i tillegg til større situasjonsbevissthet når de gjennomførte turer i snøskredterreng. Våre funn har betydning for videre arbeid med å forbedre sikkerheten i skredterreng og opplæring i skredsikkerhet.

Nøkkelord—snøskredsikkerhet, menneskelige faktorer, intensjon-atferd gap, 'mixed' metode

The incredible landscape with the many steep mountainsides characterizing Norway make many backcountry recreationalists seek the joy and adventure these mountains offer. However, the thrill of downhill skiing in untouched powder snow comes with a risk to the skier's life, as any snow-covered slopes that are steep enough have the potential to create an avalanche. In January 2019 a tragic avalanche accident caused the death of four people who were randonee skiing in Tamokdalen in Troms County, Norway (NGI, 2020). According to a technical report of the accident (NGI, 2019, p. 7), the group had in the planning phase of the trip read the avalanche warning, used steepness maps, a guidebook as well as information from locals, in order to plan the safest route to the top of the mountain. However, the site of the accident was in a different and more exposed location compared to the route the group had originally planned to take. Unfortunately, no-one will know why they did not follow their plan (NGI, 2019, p. 7) and this thesis will not try to explain why this accident happened. However, this accident suggests there might be a gap between what backcountry recreationalists plan to do, and what they end up doing when conducting trips in avalanche terrain. The phenomenon of intention-behaviour gap has been researched in multiple disciplines, for instance, in relation to physical exercise (Sniehotta, Scholz, & Schwarzer, 2005) and binge drinking (Mullan, Wong, Allom, & Pack, 2011). However, to our current knowledge, no other study has researched this in terms of recreational backcountry skiing in avalanche terrain.

We aim to improve avalanche safety by enhancing our understanding of how backcountry recreationalists plan and conduct trips in avalanche terrain. We used an embedded mixed methods design in order to investigate how backcountry recreationalists plan, conduct and evaluate such trips – and whether there was a gap between what recreationalists plan to do and what they end up doing. Moreover, we investigated whether planning and evaluating trips can contribute to learning in this difficult learning environment.

Background

Recreation in the backcountry takes place in remote, unmarked and unpatrolled mountain areas and requires independent navigation and route finding in terrain that is exposed to avalanche danger (Bonini et al., 2019). During the past few decades, the popularity of recreation in the backcountry has increased in Norway, and so has recreational avalanche fatalities (NGI, 2020). The winter season 2018-19 turned out to be one of the deadliest in the past decade and 11 individuals died while engaging in backcountry activities (NGI, 2020). The frequency of reported avalanche incidents was much higher, with 69 cases of someone being caught in an avalanche (Varsom, 2020).

The risk of snow avalanches

Avalanche terrain can be defined as snow-covered terrain that is 30 degrees or steeper and the associated runout zones of the avalanche (Tremper, 2008). The risk a backcountry skier is exposed to in avalanche terrain, is the probability of an avalanche being triggered and the associated consequences of its occurence. The probability of triggering an avalanche depends on the interaction between the steepness of the terrain, the molecular strength in the different snow layers in the snowpack, the weather conditions and the weight of the recreationalists (Landrø, Pfuhl, Engeset, Jackson, & Hetland, 2020). The consequences of an avalanche depend on the type and size of the avalanche, the steepness of the terrain and whether there are any terrain traps, such as rocks, trees or cliffs, that can cause critical injury should a recreationalist be taken by an avalanche (Landrø et al., 2020). In order to mitigate risk in avalanche terrain, the recreationalists need to evaluate the terrain, the snow cover, consider the impact of weather, as well as their exposure to different terrain elements. Such assessments are difficult and carries uncertainty (Landrø et al., 2020). This is closely related to situation awareness, which plays an important role in situations where an individual need to keep track of many and interacting factors that can change quickly (Aadland, Vikene, Varley,

& Moe, 2017; Jones, Endsley, & Jones, 1996). That is, interpretation, understanding and judgement of information from the surroundings as well as an estimate of future status is essential in being situation aware (Aadland et al., 2017; Jones et al., 1996).

Weak layers. Weak layers in the snow are often buried deep and thereby particularly difficult to assess (Landrø et al., 2020). Weak layers have weak bindings between the snow crystals in the layer and have the potential to collapse under extra stress or weight. Slab avalanches, which are high in consequence, can for instance be caused by a fracture in a weak layer that rapidly propagates, resulting in a slab of overlying snow to slide out (Gaume & Reuter, 2017). These avalanches have the potential to be large, and dry slab avalanches can reach a speed up to 130 km/h (NVE, 2016, p. 3). Moreover, a weak layer can be remotely triggered and is often loosened above the trigger point, meaning the risk of being buried or led into terrain traps is high (Landrø et al., 2020). Persistent weak layers have caused many tragic avalanche accidents in Norway (NVE, 2019, p. 3).

The impact of weather. Wind, rain and temperatures, as well as the impact of the sun, all affect the snowpack in different ways and thereby avalanche danger. Loading of snow through new snowfall, wind transportation and rain will all add extra weight to the existing snowpack, which can increase stress and instability to the old snowpack (Landrø et al., 2020). Moreover, the snow height above a hidden weak layer can be affected by changing weather, meaning the distance to a weak layer can vary within a given area. The closer the weak layer is to the surface, the easier it will be to affect it. Rain can affect the snow stability through weakening of the bonds within the snowpack, reducing strength and increasing stress on the old snowpack (Landrø et al., 2020). Measures such as safety distance while ascending and walking one-at-a-time in exposed terrain, helps reduce weight on the snowpack and enhances avalanche safety (Landrø et al., 2020). Moreover, stopping at safe spots is a measure that enhances safety if someone should trigger an avalanche (Landrø et al., 2020).

Trip planning

The Norwegian Mountain Code (ref. "Fjellvettreglene") is well known in Norway and gives recommendations and advice to people who are going on trips in mountain terrain. "Plan your trip, obtain relevant information about the weather conditions and the avalanche warning, and make sure you and your group have sufficient knowledge and practical skills to complete the trip" are some of the advices given (DNT, 2020). Having a well thought out plan is key in reducing risk on trips (Tremper, 2018) and the avalanche warning is an important source of information for recreationalists going into avalanche terrain (Baker & McGee, 2016; Furman, Shooter, & Schumann, 2010; Hallandvik, Andresen, & Aadland, 2017). In order to aid planning and decision-making, several tools have been developed to assist backcountry recreationalists, (see e.g. Munters 3x3 avalanche assessment process and reduction method), however, the different decision-making tools will not be the focus in this study.

The avalanche warning. The avalanche warning is a prediction of current and future snow instability relative to a trigger-level (McClung, 2002), and provides a prognosis of expected avalanche danger for different regions over a period of 24 hours (Engeset, Pfuhl, Landrø, Mannberg, & Hetland, 2018). The warning is issued with the aim to prevent loss of life and property damage caused by avalanches. The Norwegian avalanche warning uses both symbolic representations and descriptions in order to describe the hazards, and the warning has a pyramid-structure in which the most important information is presented first and more detailed and advanced information is presented further down (Engeset et al., 2018). More specifically, the top of the pyramid contains the avalanche danger level, a short main message that aims to inform all users about the current and expected hazard, as well as advice on how to mitigate the hazard (Engeset et al., 2018). Further down is information regarding where the avalanche danger exists in the terrain (aspects and elevation), detailed description of the current avalanche problems and the properties of the snow cover, expected likelihood of

avalanche triggering and the type and size of the avalanche. The last part includes information regarding the weather history, avalanche danger assessments and prognosis, and observations from the field reported on RegObs which is an open access real-time system (Engeset et al., 2018). It is important to note that the avalanche warning has local variability within the forecasted area (Engeset et al., 2018; Landrø et al., 2020; Techel & Schweizer, 2017), meaning recreationalists need to make their own observations and assessments of local avalanche danger while conducting trips.

The danger level and the avalanche problems are the two pieces of information that are most used by recreationalists (Engeset et al., 2018; Hallandvik et al., 2017). The danger level, which is rated on an international avalanche danger scale, ranging from 1 (low) to 5 (very high), expresses the expected probability, size and distribution of avalanches within a geographical region that is 100 km^2 or larger (EAWS, 2020). The danger level is determined from complex observations from the field. Alarm signs, such as signs of recent avalanches or instability, are the clearest signs that distinguish the higher danger levels (3 and 4) from the lower danger levels (1 and 2). However, there is no objective definition for determining danger level (Landrø et al., 2020) and experienced observers can have a disagreement rate of 22 % (Techel & Schweizer, 2017).

The avalanche problem gives detailed information on the current avalanche danger, such as what type of avalanche (dry or wet, slab or loose), the trigger mechanism, and where in the terrain the problem will be most prominent. (Engeset et al., 2018). The avalanche problem “persistent weak layers”, is often buried deep in the snowpack making it one of the most difficult avalanche problems to navigate and is sometimes referred to as an expert trap (Landrø et al., 2020). These layers can remain unstable for a long-time causing accidents day, weeks and even months after they were originally formed.

Intention-behaviour gap

A major topic of investigation within social psychology has been the relationship between intention and behaviour, and one of the most influential models in this domain is Ajzen's theory of planned behaviour (1991). The theory essentially proposes that a persons' behaviours can be predicted by his or her intentions, and these intentions are based on attitudes, subjective norms and perceived behavioural control (Ajzen, 1991). For instance, a backcountry recreationalist's attitude towards avalanche safety courses can be predictive of whether this person takes an avalanche safety course or not (Baker & McGee, 2016). However, research indicates that there is an inconsistency between forming an intention and carrying out the subsequent behaviour (Sheeran, 2002). Moreover, Mullan et al. (2011) argue that the theory of planned behaviour does not completely capture the unplanned and irrational nature of health risk behaviours. Thus, the same backcountry recreationalist can be both positive towards avalanche safety courses yet have not been on one – which can be exemplified by the young adult who told a Norwegian newspaper that he had, after the many fatalities that occurred in the backcountry the winter 2018/19 in Norway, finally signed up for the avalanche safety course that he had been thinking about taking for a long time (Pedersen & Malmo, 2020). In order to understand the different intention-behaviour inconsistencies, a number of moderators that affect this relationship have been identified, such as types of behaviour, types and properties of intentions, personality and cognitive variables (Sheeran, 2002). No studies have, to our knowledge, researched an intention-behaviour gap in terms of recreation in avalanche terrain. However, other fields researching risky health-behaviours have found such gaps between intention and behaviour, for instance, a gap in sunscreen use and sun protection behaviours (Allom, Mullan, & Sebastian, 2013), and in relation to binge drinking among university students (Mullan et al., 2011).

Human factors in avalanche terrain

A considerable body of literature has examined different snow and weather conditions that are associated with avalanche occurrence. However, the field is now recognizing human

errors to be one of the most important factors in explaining these accidents. Most fatal avalanche accidents are in 9 out of 10 cases caused by the victim or someone in the victims' group who triggered the avalanche (NVE, 2019, p. 3; Schweizer, 2004), which implies that the human perception does not always match reality (McClung, 2002). Human factors in avalanche terrain usually refer to cognitive biases and heuristic traps backcountry recreationalists can fall prey to while recreating in the backcountry (Tremper, 2018). Cognitive biases and heuristics date back to the work of Tversky and Kahneman (1974) who studied intuitive reasoning when people are faced with hard questions, insufficient information or unfamiliar situations, and found systematic biases in intuitive probability estimations and predictions. These biases could in part be predicted by heuristics, that is, mental shortcuts that are fast, automatic and intuitive and heuristics allow for subconscious and quick pattern recognition (Tversky & Kahneman, 1974). Heuristics are useful in everyday life, for instance while driving a car, yet erroneous in situations where information is insufficient (Tversky & Kahneman, 1974). In fact, heuristics can become dangerously misleading in avalanche terrain as they can give an inaccurate perception of a slope, in which they become heuristic traps (McCammon, 2004a). McCammon (2004) used avalanche accident statistics to study how any recreationalists, even avalanche experts, could act against the rational, 'ignoring' obvious signs of avalanche danger. In this work he found six heuristics, under the acronym FACETS, that helped explain these accidents (McCammon, 2004a) – familiarity, acceptance, consistency, expert halo, tracks, and social facilitation. For instance, in order to get noticed or accepted, people tend to engage in activities that will get them noticed and respected, which is the heuristic trap McCammon called 'acceptance' (McCammon, 2004a). In another heuristic trap, 'social facilitation', a person or a group who is confident in their skill will in the presence of others tend to take more risks using those skills (McCammon, 2004a). This heuristic is closely related to group polarization, in which a

group can move towards a more extreme point that is in the same direction of the members original tendencies, which can lead to risky shifts (Friedkin, 1999; Sunstein, 2002). Risky shifts have been observed in groups traveling in avalanche terrain (McCammon, 2004a; Tremper, 2018). Later work has identified many more heuristics traps and cognitive biases, for instance optimistic bias and overconfidence. Optimistic bias is a tendency for people to believe they are more likely than the average person to experience positive events or conversely less likely to experience negative events than the average person (Weinstein, 1980). Middleton et al. (1996) found this bias in bungee jumpers, as participants perceived the risk of injury to be lower compared with their fellow jumpers. Overconfidence is a cognitive bias that occurs when a person or a group overestimates the accuracy of their judgements, decisions or predictions (Sanchez & Dunning, 2018), and can lead to excessive risk-taking in both beginners and experts (Bonini et al., 2019; Sanchez & Dunning, 2018) Importantly, if feedback is constrained, unavailable or incomplete, people might fail to correct this bias (Sanchez & Dunning, 2018), meaning the excessive risk-taking will continue on. This prevalence of this bias among backcountry recreationalists has been found to be high, as Bonini et al. (2019) found that 53 % of their sample of backcountry skiers were overconfident. However, it should be noted that their sample consisted predominantly of middle-aged, experienced and skilled males who were strongly committed to backcountry skiing.

Human factors is a broad term. Thus, there are many other personal, interpersonal and situational factors that can further influence behaviour in avalanche terrain, for instance, communication, leadership, conformity pressures, groupthink, personality and risk perception, among others.

Group performance. Literature in social psychology has illustrated that groups in general perform better and make better decisions than individuals (Kerr & Tindale, 2004). Groups

have better capacities to gather information, process that information, exchange opinions and correct potential errors of group members through communication (Kugler, Kausel, Kocher, & Kugler, 2012). In avalanche safety literature, effective and open communication has been found to be fundamental for creating shared mental models among backcountry recreationalists and has helped reduce subjective biases (Adams, 2005, p. 213). Furthermore, a group's performance in avalanche terrain has been linked to leadership (Adams, 2005; McCammon, 2004a; Zweifel & Haegeli, 2014). However, these positive aspects of groups do not always lead to improved group performance (Kerr & Tindale, 2004). For instance, groups with poor communication are more susceptible to negative group influences (Zweifel & Haegeli, 2014). Moreover, a dominant explanation for the phenomenon of group polarization is that arguments and facts might become too supportive and reinforcing of the dominant initial position of the group (Whyte, 1998). This is closely related to groupthink, a phenomenon that was initially identified by Irving L. Janis and involve a strong concurrence-seeking tendency among group members that might interfere with a group's decision-making ("Groupthink", n.d.). That is, judgements might be impaired and critical independent thinking lost due to, among other things, apparent unanimity in the group. The processes involved in groupthink are not fully understood (Hogg & Hains, 1998; Kerr & Tindale, 2004), however some explanatory causes are thought to be group cohesion (Hogg & Hains, 1998), group self-efficacy (Whyte, 1998), and/or poor leadership ("Groupthink", n.d.).

Risk perception. When faced with a hazard, it is up to an individual's subjective risk perception to estimate the probability of an hazard occurring and the potential harm it might cause (Breakwell, 2014, p. 14). Estimating risks involves an evaluation of possible benefits against possible costs (Breakwell, 2014, p. 22). Perceived benefits are crucial for the acceptance of risks, and the likelihood of risk behaviour has been found to increase for recreational risks (Weber, Blais & Betz, 2002). Recreation in the backcountry involves

voluntary risk-taking and is first and foremost associated with positive affective experiences (McCammon, 2004b). In fact, during extreme sports, individuals can experience intense and euphoric feelings of joy and elation (Hetland & Vittersø, 2012) which contributes to the perceived benefits. People who engage in extreme sports have been shown to have a higher tendency of certain personality characteristics, such as sensation seeking and impulsivity (Zuckerman, 1983). An important factor in backcountry skiing is mastering the challenge of skiing. Thus, the risk involved in recreating in the backcountry is not a goal in itself, but rather a necessary consequence of creating a challenge the skier can master. Therefore, an increase in skiing abilities might cause skiers to negotiate steeper terrain without an accompanying increase in skills in evaluating and mitigating avalanche danger. Features of the self-concept such as self-efficacy, that is, an individual's judgement of his or her capabilities to perform in such a way that he or she have control over events that affect life (Breakwell, 2014, p. 61), has moreover been identified to influence involvement in high-risk recreational activities (Breakwell, 2014, p. 62).

Learning in a wicked environment

From our past experiences, we make inferences, abstractions and generalizations, which guide our future behaviour. However, avalanche terrain is a so-called wicked learning environment, meaning the feedback from the terrain is unrepresentative and might cause interpretation of these past experiences to become inaccurate and misleading (Hertwig, Hogarth & Lejarraga, 2018). McClung (2002) argues that in cases where there are clear signs of avalanche danger, the human perception of the risk and the reality have a fairly good match. However, when instability is local and not obvious, which is the case most of the time in avalanche terrain, human perception will have larger variations, higher uncertainty and might become more biased (McClung, 2002). Moreover, because the snow is stable 95 % of the time, recreationalists might gate away with poor decisions for years (Tremper, 2018,

ebook location 5609), and the risk of avalanches might become an abstract risk as there are few people who experience it first-hand. A body of evidence suggests there is a fundamental difference in learning from first-hand experience rather than a mere description of possible consequences (Hertwig et al., 2018). Descriptive learning involves the processing of spoken or written words, symbols and/or numbers, and allows for sharing of knowledge and wisdom. However, such information is abstract and therefore cannot substitute an individual's real experience with the environment (Hertwig et al., 2018). In contrast, learning from experience will often have greater influence on future behaviour, and this is especially true if the experiences have material consequences (Hertwig et al., 2018). For backcountry recreationalists, it might take a long time to learn the negative consequences of poor habits and decisions (Tremper, 2018, ebook location 5605).

This difficult learning environment raises questions of how recreationalists, particularly beginners, can acquire expertise in the absence of valid feedback. Haegeli et al. (2010) argue that becoming an avalanche expert requires training, experience and knowledge of the avalanche phenomena, and that one promising way to enhance avalanche skills can be through deliberate practice, critical thinking and reflection (Haegeli, Haider, Longland, Beardmore, & Haegeli, 2010). Deliberate practice dates back to Ericsson et al. (1993), who studied expertise and top performance in a variety of domains, and found that expertise is best learned through prolonged and deliberate practice in predictable environments with clear feedback that helps correct errors made. Deliberate practice entail effort as it is slow and demands a heightened sense of awareness – as opposed to fast and automatic thinking (Ericsson et al., 1993).

The present study

Based on the above literature review the following research questions were investigated:

1. What information did the participants gather when planning trips in avalanche terrain?
2. How did the participants conduct trips in avalanche terrain regarding safety measures and observations?
3. Was there a difference between what the participants planned to do and what they reported to have done, and if so, how did they justify this?
4. Could answering questions before and after trips contribute to learning?

Method and Design

Choice of method

In order to investigate the research questions, this study used a mixed method design with an embedded methods approach. In embedded designs, one data set provides the primary data for the study and the second set of data provides a supportive, secondary role (Halcomb & Hickman, 2015). For this study, the qualitative data were given priority. See Figure 1 for an overview of the design.

The rationale for collecting both quantitative and qualitative data for this study was that neither methods were enough by themselves to capture the trends, details and experiences from recreation in this complex, potentially hazardous, environment. By combining both qualitative data and quantitative data within a single study, one moves from the dichotomy of quantitative methods versus qualitative methods and towards recognizing both approaches as important, which can provide broader and deeper understanding of the research topic, and further expand and strengthen a study's validity and conclusions (Doyle, Brady, & Byrne, 2016; Schoonenboom & Johnson, 2017). The strength of qualitative research methods is that they ask open-ended questions without predefined response categories, which gives nuanced, complex and rich data (Braun & Clarke, 2006). The qualitative data can therefore give us valuable insight into backcountry skiers experiences, thoughts and reflections regarding planning, conducting and evaluating trips in avalanche terrain. Quantitative research methods

have the advantage of providing large numerical datasets that can be analysed statistically for any trends and relationships within the data (Watson, 2015). Quantitative data regarding planning and conducting trips can thereby give a context to the qualitative findings.

The qualitative data were obtained through semi-structured interviews, while the quantitative data were obtained through surveys. Both types of data were collected from the same sample of participants and analyses of the quantitative and qualitative data were conducted independently. Qualitative data collection commenced after the completion of the quantitative data collection. In the final phase of analysis, quantitative results and qualitative findings were integrated and interpreted.

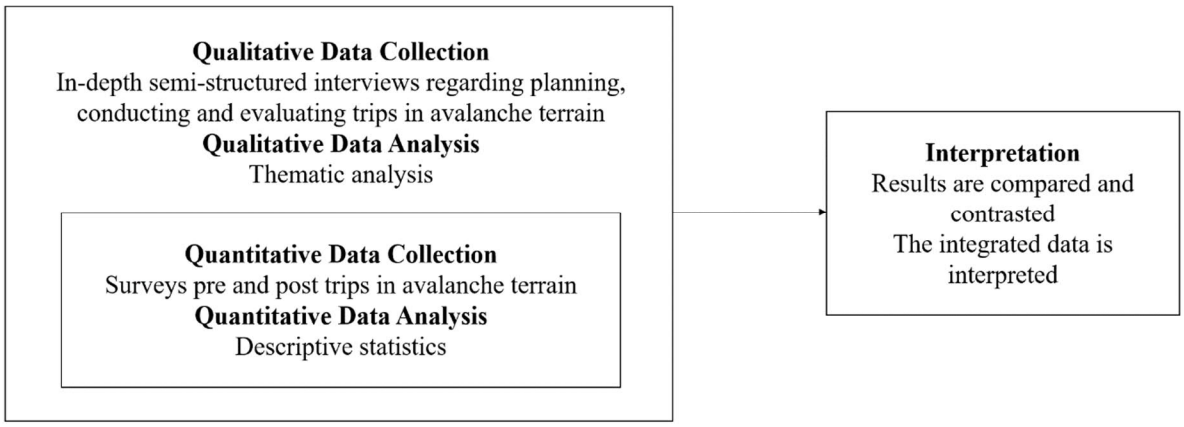

Figure 1. Mixed method design with an embedded methods approach

Researcher Description

This study was done in collaboration with The Norwegian Avalanche Warning Service run by NVE and Center for Avalanche Research and Education (CARE). CARE is an interdisciplinary research centre that study decision making in avalanche terrain in order to improve decision-making and reduce loss of lives.

The author of this study has no personal experience with backcountry skiing, and at the time of the interviews, the author had little knowledge regarding the technicalities of snow and avalanches. This background has both disadvantages and advantages. For instance, lack

of knowledge can lead to loss of important nuances in the participants narratives. However, not having personal experiences with skiing in the backcountry helped make the interviews open and less influenced by personal experiences and knowledge from the interviewer.

Recruitment strategy

Through convenience sampling, participants were invited to participate online through Varsom.no, which is the same webpage that provides warnings related to natural hazards, including avalanche danger. Moreover, students at Svalbard and Nordfjord Folkehøyskole were encouraged by their instructors to participate in the study. Participants were eligible for participation if they were 18 years old or older.

For the qualitative data collection, through strategic sampling, a subsample of individuals was contacted through direct e-mail solicitation during the summer of 2019. These individuals were asked to participate in a follow-up interview, in which they would be asked about how they plan and conduct trips in avalanche terrain. They were informed that the interviews would be audio recorded, or in some cases video recorded, and that the transcribed interviews would be anonymized and used in connection with a master thesis and a publication. Individuals who did not initially respond were contacted on Facebook a week later where they were kindly asked for a response regarding the email. All responded positively except for one who never responded. Individuals were given a cap as a thank you for completing the interview.

Participants

In all, a sample consisting of 23 backcountry recreationalists participated in our study. For the quantitative data, the sample included more males (61.1 %) than females (38.9 %). The majority (70.5 %) were between 18 – 25 years old, while 17.7 % were between 30 – 35 years old and 11.8 % were between 50 – 54 years old. Our participants had varying levels of experience as the minimum number of years skiing in the backcountry was 1 year and the

maximum was 35 years (M = 10.4, SD = 10.7). Furthermore, the participants reported they typically went skiing for minimum 3 times to maximum 50 times on average per year (M = 21.8, SD = 13.5).

For the qualitative data, the participants comprised of five males and three females. All were in the ages of 18 – 25 years, except for one participant who was in her thirties. Similarly, these participants had varying levels of experience, as some had been backcountry skiing for 1 year whereas others had been backcountry skiing for 5 to 10+ years. All had basic knowledge of avalanche hazard and had been on avalanche safety courses.

Quantitative data collection

The quantitative data were collected through an online survey management software called Qualtrics. During the winter season 2018/19, participants answered a short questionnaire before a trip in avalanche terrain (survey A, pre-trip) and a short questionnaire after the trip was completed (survey B, post-trip). In addition, the participants reported demographic information in a third questionnaire (survey C.) All questionnaires were in Norwegian. Survey A consisted of 17 questions, and approximate time for completing this survey was 4 – 8 minutes, whereas survey B consisted of 35 questions and approximate time for completing this survey was 10 – 15 minutes. The participants completed one set of questionnaires for each trip and could log as many trips as they wished during the data collection period. The surveys were designed by NVE and CARE and made as part of the general NVE and CARE project and thus not specifically for this study. The questions in the surveys were constructed based on feedback from a panel of avalanche experts.

Survey A. Through answering survey A, the participants essentially planned their trip. More specifically, these questions aimed to map whether the participants had a plan (e.g. “Do you have a plan with evaluation points?”), how familiar they were with the terrain (e.g. “Have you done the trip before?”) and conditions (e.g. “Did you read the avalanche warning?”), as well

as questions related to planned observations and tests (e.g. “Do you plan on doing observations and/or tests of avalanche danger?”). These questions had different response categories the participant could choose between (e.g. “Yes”, “No” and “To some extent”), and for some questions the participants could choose multiple response alternatives (e.g. choose both “Look and listen for signs of avalanche danger” and “Do quick tests with ski pole or hand”). The participants were also asked to rate different statements (e.g. “How manageable do you consider the snow cover to be?”) on a 6-point Likert scale, where 1 indicates very unsafe and 6 indicates very safe.

Survey B. Through answering survey B, the participants essentially evaluated their completed trip. The questions in survey B aimed to map what the participants had seen (e.g. “Did you observe any signs of avalanche danger?”) and done on the completed trip (e.g. “Did you follow the plan?”). Similarly to survey A, these questions had different response categories, and for some of the questions the participants could choose multiple response alternatives. In addition, participants were asked to rate different statements (e.g. “We made good evaluations of the avalanche danger”) on a 6-point Likert scale, where 1 indicated strong disagreement and 6 indicated strong agreement.

Qualitative data collection

The qualitative data collection and analysis utilized a phenomenological approach with a descriptive design drawing upon data from interviews and photo elicitation. Phenomenological approaches focus on the individuals’ subjective experiences and perspectives (Dermot, 2019). Accordingly, semi-structured interviews was the chosen approach of inquiry. Semi-structured interviews have the advantage of asking a series of predetermined open-ended questions while at the same time being open to digressions, which can provide deep and valuable insights (Creswell & Miller, 2000; Kvale, Brinkmann, Anderssen, & Rygge, 2015). Due to logistics, the eight semi-structured interviews were

conducted after the completion of the quantitative data collection. One main advantage of the prolonged period between the quantitative and qualitative data collection was that the participants did not have the survey questions fresh in memory, meaning the participants had to recall knowledge unprompted and were not shaped by the researchers choosing and wording of the survey questions.

We designed the interview guide (see Appendix B) with open-ended questions that aimed to get the participants to talk about a typical trip in avalanche terrain and more specifically, about the different stages in a trip – from planning at home (e.g. "do you plan before going out?"), to driving out to the designated area and beginning the trip (e.g. "do you do anything in particular regarding avalanche danger while going up?"), descending (e.g. "do you do anything in particular before descending?"), and getting back home again (e.g. "do you evaluate the trip?"). Moreover, a second part of the interview guide was designed to get the participants to tell freely about a specific trip they had registered in the surveys during the winter season 2018/19. To help memory recall, the participants were asked to find photos from the trip prior to the interview. Photo elicitation, that is, using photographs in an interview, can be used to evoke feelings and memories which enhances the depth of meaning and information (Harper, 2002). In a third part of the interview, the participants were asked about the project and how answering questions before and after trips had been like.

The interviews ended when the interviewee did not have anything more to add. The interviews took place at a mutually agreed upon time and place in quiet, undisturbed rooms. The participants provided written consent before the interview started (see Appendix A for consent form). Five of the interviews were conducted face-to-face and recorded on an audio recorder, whereas three interviews were conducted over Skype and video recorded. The interviews lasted on average 56 minutes, where the shortest interview lasted for 40 minutes

and the longest interview lasted for 1 hour and 10 minutes. All interviews were conducted in Norwegian.

Transcription. When transcribing the interviews, the focus was on preserving the original material as best as possible. The transcripts were written down in the informants' spoken language (Norwegian), as close to the original conversation as possible. Pauses, repetitions, as well as words that were not completed, were included in the transcripts. For the video interviews, additional body language such as shaking of the head, shrugs etc. were included in the transcripts. Words or sentences that were inaudible or incomprehensible was listed as '(*not audible*)'. Transcriptions of the tapes were reviewed line by line for accuracy against the audio- and videotape.

Research ethics

The study was reported to, and approved by, the Norwegian Centre for Research Data (NSD) (number 733888). Important ethical principles were adhered to during the study. Participating in both the quantitative and the qualitative study was voluntary and the participants were free to withdraw from participating at any given point during the data collection period, giving no reason and facing no consequences. In such a case the data collected would be deleted unless the data already had been included in analyses or used in scientific publications.

Informed consent. For the quantitative data collection, the opening page of the survey contained information regarding the study and before continuing the survey, the participants needed to confirm they were 18 years old or older and that their answers could be used by both NVE to improve Varsom.no / RegObs and CARE for research.

For the qualitative data collection, the participants were informed of the study both orally and in writing, and all participants signed the consent form before the interview started (see Appendix A).

Anonymity. In the quantitative data collection, participants provided their email addresses when they first registered, as well as a personal id-code. Having the participants' email addresses was necessary for contacting eligible participants for later interviews. The participants used the id-code when answering survey A and B, which were later used in the data analysis to connect responses from one person in survey A to the associated responses from the same person in survey B. To ensure anonymity, the document connecting the id-code to the email addresses have been stored on locked computers and no one outside the project have had access to this document.

To ensure anonymity within the qualitative data, the transcribed interviews were anonymized and the original names of the participants, as well as names of other people mentioned, were given pseudonyms. Places of residence and other information that could reveal the identity of the participants were removed. The anonymous transcripts, the audio recordings and the video recordings have been stored on a locked computer and no one outside the project have access to them. The audio and video recordings will be deleted no later than one year after the master thesis is submitted (4th of May 2020).

Quantitative data analysis

Responses in survey A were linked to responses in survey B if the same id-code had been used to answer both survey A and B within a maximum of three days. Registered responses were not included in the final dataset if only survey A or B had been answered. The final dataset comprised of 196 responses to the surveys which were successfully linked, making 98 completed trips (pre and post) that were analysed.

Statistical analyses were conducted in SPSS (Statistical Package for the Social Sciences, version 26). Standard descriptive statistics were used to describe the sample, and frequency and descriptive data were used to describe trends within the dataset. In order to investigate a potential gap between what the participants planned to do (survey A) and what

they reported doing (survey B), the frequencies pertaining to the questions that were phrased exactly the same in survey A and survey B were compared directly. Moreover, the differences between the frequencies of these questions (pre and post trips) were tested using a One-Sample t-test set against the test-value of zero difference.

Qualitative data analysis

With the research focus being on experiences, opinions and perceptions of the participants, thematic analysis with a realist approach was the chosen analysis strategy (Braun & Clarke, 2006). Thematic analysis can be used within different theoretical frameworks, including phenomenology, and provides a useful and flexible research tool (Braun & Clarke, 2006). Further, the analysis had an inductive approach, which allows for the data to determine the themes. In other words, the coding was diverse and without trying to code data into a pre-existing theoretical frame (Braun & Clarke, 2006). Six phases, developed by Braun and Clarke (2006), were followed during the thematic analysis of the written transcripts:

The first phase involved familiarization with the data material, with the goal of getting a sense of depth and breadth of the content. This initial step occurred while conducting the interviews, transcribing the audio- and video recordings, reading the finished transcripts and writing initial notes regarding thoughts and reflections about the data (Braun & Clarke, 2006).

The second phase involved initial coding and sorting of the data. More than 200 pages of double-spaced transcribed data were analysed using NVivo (version 12). Codes are the most basic segment of raw data that highlights sections of text that are regarded as meaningful and interesting to the phenomenon being studied (Braun & Clarke, 2006), for instance a feeling the participant expressed or something he or she experienced. The coding for this study was data driven, and nearly the entire dataset was coded. Some extracts of data were coded once, others were coded several times. Sentences where there was uncertainty about what was said were discarded.

The third phase involved searching for themes in the long list of codes that had been identified in phase two. Based on similarities and inequalities across the different codes, the codes were sorted into potential themes. Themes are broader than codes and captures something important related to the research question (Braun & Clarke, 2006), and they balance on being broad enough to be applied to more than one context as well as narrow enough to distinguish the nuances (Kvale et al., 2015). Some codes were synonyms or had the same meaning and could be combined to form an overarching theme. Other codes could be understood as subcategories of each other. Yet other codes were discarded or lost as they were not relevant to the problem or fell under other codes (Braun & Clarke, 2006).

The fourth phase involved reviewing and refining the candidate themes and sub-themes from phase three. The themes were compared to the raw data, making sure the themes were useful and accurate representations, that the data cohered together meaningfully and that nothing important was left out. Sub-themes, which demonstrate the hierarchy of meaning within the data (Braun & Clarke, 2006) were reviewed, making sure the structure within the bigger theme made sense. Moreover, the candidate themes were compared to each other, making sure there were clear and identifiable distinctions between them (Braun & Clarke, 2006). In this process, some themes were combined, some were split up (because of too diverse data), discarded or turned into a new theme. Themes and sub-themes were relabelled to achieve the best fit across the data.

The fifth phase involves defining and refining the themes from phase four. This involved analysing each theme in detail and formulating the characteristics of the theme, as well as conditions, causes and consequences of the content. It was determined what aspects the theme captured and why the content was interesting (Braun & Clarke, 2006). The story each theme told was identified, as well as the broader overall story that is told about the themes in relation to each other.

The last phase involved final analysis and writing up of the data. The final themes were explained in a narrative style and substantiated by quotes from the participants.

Throughout the data analysis process, three meetings were held with the supervisor and co-advisor to ensure quality in the analyses. Codes, theme and sub-themes were discussed, which helped to identify which codes and themes should be further modified and clarified. Discussions such as these helps to ensure the analysis is not limited to one perspective (Creswell & Miller, 2000).

Notes and memos. Notes were written continuously throughout the whole research process. Field notes were written during the data collection and own observations and reflections, as well as comments and thoughts, were written down. Field notes are important in qualitative studies as they capture impressions and reflections that would otherwise not have been captured (Malterud, 2017). The memos written during the analysis show the steps back and forth in the analysis, the decisions made, descriptions of the evolution of the codes and themes, as well as ideas, thoughts and interpretations. Having paper-trails such as this is a method for strengthening validity in the qualitative findings, as it documents the path from raw data to findings (Creswell & Miller, 2000).

The mixed methods data integration

In the integration phase, quantitative results and qualitative findings were integrated and interpreted. The different results and findings were comprehensive, thus not all quantitative results and qualitative findings matched or were related to the research questions. Thus, some results from the quantitative analysis and some findings from the qualitative analysis were excluded in the integration of the two datasets.

More specifically, in the data integration, for each topic that was related to the research questions, concordance and consistency between the quantitative results and the qualitative findings was assessed. For instance, qualitative findings regarding the participants

accounts of how they typically plan their trips were compared and contrasted with the quantitative results pertaining to planning. In this way, the qualitative findings could enrich or explain the quantitative results, or the quantitative results could give a context to the qualitative findings. Moreover, any inconsistencies between the two datasets would in this way be identified.

Results and Findings

Quantitative results

The quantitative results are summarized in Tables 2 – 8.

Qualitative findings

In the qualitative analysis, three overarching themes were identified: (1) planning and conducting trips, (2) group dynamics, and (3) individual cognition and behaviour. The main themes with associated sub-themes are summarized in Table 1. In sum, the first theme, planning and conducting trips entail how the participants typically prepared before going out and how they mitigated avalanche risk on their trips. The second theme, group dynamics, entail how a group might interact on trips and how different group roles and structures could influence decision outcomes. The last theme, individual cognition and behaviour, entail how personal motivation and goals might overshadow awareness of avalanche danger and how previous experiences can affect risk acceptance.

Table 1

Three Main Themes from the Qualitative Analysis with Associated Sub-Themes

Planning, conducting and evaluating trips	**Group dynamics**	**Individual cognition and behaviour**
Information gathering	Responsibility and trust	Personal risk acceptance
Planning the trip	Group interaction	Personal motivation and goals
Snow assessments	Group influence	Previous experiences
Strategies for managing terrain		Learning and self-development
Adapting plans		

Evaluating

Integrated results and findings

Overall, both the quantitative results and the qualitative findings shed light on the research questions and reveal different aspect important to planning, conducting and evaluating trips in avalanche terrain. The following sections present both quantitative results and qualitative findings pertaining to the different aspects.

Planning trips

In the quantitative results, the majority (65.7 %) did not have a plan with evaluation points for their trip. However, 70.4 % reported they planned on making observations and/or tests and a clear majority (85.7 %) reported they read the avalanche warning before going out, which indicates the participants prepared to some extent before their trips. Information about the terrain was also collected from other sources, such as maps, other participants in the group or other skiers. The majority of the participants (54.6 %) reported that they had never taken the trip before, while 11 % said they had taken the trip 11 times or more, which indicates a wide range of familiarity with the trip among the participants. They further reported being quite familiar with the snow conditions as they either lived in the area (52.0 %) and/or had been on trips in the relevant area recently (44.9 %).

In the qualitative interviews, all participants would plan to some extent before their trips. That is, they all prepared by reading the avalanche warning and checking the weather forecast. Observations registered in RegObs were often used as a supplement. Based on this information, they made a more or less detailed plan. However, the extent of detail in those plans varied. Some participants figured out the route they wanted to go before leaving home, as one participant said:

> *I look at the map and make a quick plan, just look at the steepness map and try to understand where I should go. (male, early twenties)*

Others had more of a general idea of an area and made detailed plans while out in the terrain, as another participant said:

> *Part of the trip planning is also carried out in the car but it's not that we necessarily-, because the plan we initially have is sort of a preliminary plan, it might just be an area, it might not even be a mountain, or it's two or three different thoughts that we might be able to do, and then we drive out and see. (female, early thirties)*

Another factor that affected degree of planning was whether they were going in familiar or unfamiliar terrain. Going in terrain they knew well was typically characterized by less planning, whereas trips in unfamiliar terrain typically involved more planning, as one of the participants said:

> *If it's a new trip that I haven't done before then definitely. If it's a trip I've done many times, then the planning most often entails checking the weather and such. (female, early twenties)*

Overall, the quantitative results and qualitative findings are in concordance and illustrated that preparing before going out is essential. However, the quantitative results indicate that having a specific plan with evaluation points is not that common, yet the qualitative findings shed further light on what the participants' planning process might look like. The participants do plan; however, this plan is more overarching and developed or updated on-site. The quantitative results indicated that the participants conducted familiar trips in nearly half of the time, and many reported having been on other trip(s) in the same area recently, which might lead to less planning before the trip.

Reading the avalanche warning. In the quantitative results, a clear majority (85.7 %) read the avalanche warning. When asked what the most important piece of information from the avalanche warning was, the participants answered the avalanche problems (48.8 %). See Table 2 and Table 3 for summarized results.

Table 2
Use of Avalanche Warning when Planning Trips

Check of avalanche warning	**%**	**Influence**	**%**
Yes, I read the avalanche warning	85.7	It was crucial for choice of trip	11.2
		It affected choice of trip to some extent	44.9
		It did not affect choice of trip	29.6
No, I did not read the avalanche warning	14.2		

Table 3
Priority of Perceived Importance of the Different Elements in the Avalanche Warning (Pre-trip Survey A)

Most important information from the avalanche warning	%
Avalanche problems	44.8
Snow cover historic	19.8
Danger level	12.5
Mountain weather prognosis	8.3
Observations from RegObs	4.2
Someone else used information from the avalanche warning	5.2
Did not use information from the avalanche warning	5.2

This is in concordance with the interviews. When looking up information in the avalanche warning, their main attention would be on the avalanche problems, in which they wanted to know what the unsafe layers in the snow were and where these problems were located. This was particularly true if the avalanche danger level was low (i.e. one or two). Making deliberate plans based on the information in the avalanche warning was common, as one participant said:

> *For one thing is to know what the problem is, but you also need to have a plan and know that you're safe. (female, early twenties)*

Interestingly, another participant reflected around how he only paid attention to the information he understood while ignoring the rest of the information:

> *I focus on the things that are easy to recognize and that's a paradox in a way, that I close my eyes and almost ignore the things I don't understand while being open and*

play on the things I can. (...) So that's a bit, that's something I think about, but yeah. (male, early twenties)

Focusing on the avalanche problems was the norm among the participants. However, the danger level became more heavily emphasized by the participants if the number was three or higher, in which they all made more careful evaluations of the terrain they wanted to go into. Everyone cancelled their plans if the danger level was four or higher. In contrast to the others, one participant did not normally read about the avalanche problems when the danger level was low (i.e. one or two), as he said:

I first and foremost look at the danger level and that's often enough if it's low (...) If it's a two then I think okay I don't need to read further and I'll just consider what it's like when I come up (...) Maybe not textbook but that's what you do. (male, early twenties)

Overall, the quantitative results and qualitative findings are in concordance as both emphasize the importance of the avalanche warning and in particular the information regarding the avalanche problems. The qualitative findings illustrate the dynamic in reading the avalanche warning, in which the danger level was more heavily emphasized by all the participants when it was high (i.e. three or higher). Interestingly, the qualitative findings show how the participants weighted the information in the avalanche warning differently and furthermore, how that information could influence thought processes while being in avalanche terrain.

Conducting trips

Snow assessments. In the quantitative results, a clear majority (87.8 %) reported they had done observations and/or tests on their trips. When asked what the most important observations and/or tests were, the participants reported listening and looking for danger signs (79.6 %) and do quick tests with ski poles or hand (62.2 %). See Table 4 for summarized results.

Table 4
Planned and Self-Reported Observations and Travel Behaviour and Calculated Difference Between Answers in A and B for Each Variable

Observations and / or tests	**Frequency pre-trip (%)**	**Frequency post-trip (%)**	**Difference between A and B**
Look and listen for signs of avalanche danger	87.8	79.6	8,2
Quick tests with ski pole or hand	73.5	62.2	11,3
"Testheng"	15.3	12.2	3,1
Snow profile	27.6	24.5	3,1
Tests of stability (CT, ECT, PST)	19.4	16.3	3,1
Systematic investigation of snow cover	11.2	12.2	-1,0
Travel behaviour			
Safety distance while going up	23.5	15.3	8,2
Stop at only avalanche safe places	43.9	27.6	16,3
One and one while descending	22.4	19.4	3,0
Only disciplined descents	27.6	17.3	10,3

This is in concordance with the interviews. The participants talked about constantly observing their surroundings, looking for the avalanche problems they had read about in the avalanche warning and looking for any changes in weather and snow conditions while conducting their trip. Throughout the trip, they would pay attention to any terrain traps and avoid runout zones. Moreover, in order to evaluate the layers in the snowpack and the hardness of the snow, the participants would stick their ski poles or touch the snow with their hand. They became extra aware of the danger in exposed terrain, as one participant said:

I'm even more busy with sticking my ski pole in the snow and digging with my hand trying to get an impression when I know it's steep enough. (male, early twenties)

Many participants found it difficult to make these assessments of the snow due to local variations, as one participant said:

I think it's difficult, it's often very local and that's the case in many places. (female, early twenties)

Interestingly, another participant pointed out that going the same route in familiar terrain could affect her awareness of risk, as she said:

> *If it's very straightforward and I've done the trip before and the weather is nice and the snow is nice, then I'm not so conscious, then I just go where I always go without thinking it over, which yeah, can be dangerous too. But there's something about this habit, that you get used to a place, used to a trip and then you don't think about where you walk. (female, early twenties)*

Overall, the quantitative results and qualitative findings were in concordance. The participants paid attention to their surrounding and made their own assessments when conducting trips. However, making these assessments could be challenging, and going in familiar terrain could affect their situation awareness.

Adapting plans. In the quantitative results, the most reported signs of avalanche danger were fresh wind transported snow (40.8 %), fresh avalanches (18.4 %) and shooting cracks (16.3 %). Observations and/or tests of avalanche danger influenced to some extent (37.8 %) or was crucial (17.3 %) when deciding where to go. See Table 5 and Table 6 for summarized results.

Table 5
Observed Signs of Avalanche Danger (Post-trip Survey B)

Observed signs of avalanche danger	**%**
Fresh avalanches	18.4
Shooting cracks	16.3
Quick increase in temperature	4.1
Fresh wind transported snow	40.8
Whoomph-like sounds	11.2
Heavy snowfall	10.2
Water condensed snow	8.2
No / None of the above / Other	31.6

Table 6
Influence of Observations and Tests on Trips (Post-trip Survey B)

Variable / Statement	**Yes, was crucial**	**To some extent**	**No**
Did observations affect route choices?	17.3 %	37.8 %	32.7 %
Did you follow their plan?	64.6 %	22.9 %	12.5 %
Did you use the evaluation points?	42.1 %	27.4 %	30.5 %

This is in concordance with the interviews. Based on observations of avalanche danger, the participants would adapt their plans to make it safer. Adapting plans and choosing a different route could happen quite often, usually because of conditions and/or the terrain being more complicated than originally thought. Moreover, observations of certain danger signs could make them re-evaluate the whole trip, as one participant said:

> *If I see danger signs then I immediately become more sceptical and I stay far away from avalanche terrain. (...) And if I don't find any of them, I'm less sceptical. (male, early twenties)*

Overall, both quantitative results and qualitative findings show that participants adapt their plans based on observations of avalanche danger.

Strategies for mitigating risk. In the quantitative results, the top three most reported travel behaviours used on their trip were to stop at only avalanche safe places (27.6 %), to have only one and one while descending (19.4 %) and to only do disciplined descents (17.3 %) (reported responses from survey B). See Table 4 for summarized results.

This is in concordance with the interviews. When walking up the mountain, the participants would stop at safe spots, in which they wanted to look around, evaluate the snow and find the safest way up. Having a safety distance while going up the steepest parts of the mountain was common, and when descending, they skied disciplined and stopped at safe spots. While descending, the participants would pay close attention to the snow underneath the skis and adjust their line down continuously. Furthermore, to know what snow they were skiing on, descending the same side of the mountain as they walked up was the most common strategy, in which their assessments of avalanche danger would stop:

> *At the top, I get very excited, and I feel most of the job of assessing the avalanche danger is over. And the reason for that is because I often ski down the same side I walked up. (male, early twenties)*

However, skiing down a new side happened regularly, as another participant said:

> *I often ski down somewhere else and then it becomes something completely different. Then you must consider, then there's another steepness and cardinal points and yeah. (female, early thirties).*

In order to mitigate risk in these cases, the participants would do ski cuts in order to check if anything would trigger, as another participant said:

> *I often do ski cuts to try to see, okay, is this an obviously bad idea? (male, early twenties).*

Overall, the quantitative results and qualitative findings are in concordance regarding the use of risk mitigating strategies. However, after reaching the top, avalanche danger assessments might stop. Which side of the mountain the participants would descend varied.

Evaluating

In the quantitative results, the participants gave high ratings when asked to rate both the statement "We made good evaluations of the avalanche danger" and the statement "How confident were you of route choices regarding avalanche danger. See Table 8 for summarized results.

In the qualitative interviews, only two of the participants said they would do a quick, mental evaluation of the trip after its completion, in which they would typically think about their decisions and whether they matched the avalanche conditions. In contrast, the majority did not usually evaluate their trips and would only evaluate if something negative or something out of the ordinary happened on the trip. After completing trips, their main focus would typically be on the fun and excitement of having been outdoors skiing, as one participant said when he reflected around why he did not evaluate after a trip:

> *It's very easy to forget it when you've skied down and everything went well and the mood is good and there's a bit of euphoria in your head. (male, early twenties).*

Moreover, due to the uncertainty involved in assessing avalanche danger, many of the participants found it difficult to evaluate their avalanche assessments anyway:

> *I still feel that I'm at that level where it's totally bingo if I come back with my friends and everything went well and we think 'damn, we were good, we evaluated that fine', yet we don't know if we were one meter from triggering an avalanche. So, I might think that I did the right thing, that I evaluated the avalanche danger just right, when I really was just lucky. So, you feel good and a sense of achievement but with a bitter taste. (male, early twenties)*

Overall, the qualitative interviews found that the majority of the participants rarely evaluated their trips and that they mainly focused on the positive experiences after their trips. Interestingly, the quantitative results and qualitative findings are in discordance regarding evaluating their avalanche assessments, as the quantitative results indicate that the participants were quite confident in own assessments of avalanche danger yet the participants in the interviews found it difficult to evaluate their own avalanche danger assessments.

Intention-behaviour gap. In the quantitative results, out of those who had a plan for their trip, the majority (64.6 %) reported they had followed, or mostly followed (22.9 %), their plan. In Table 3, there is a trend of lower values of self-reported behaviour after the trip, compared with planned behaviour before the trip. Moreover, there was a significant difference between pre and post answers ($M = 6.6$, $SD = 5.2$) when tested against the test value of zero (no difference), $t(9) = 4.0$, $p < .05$, 95% CI [2.85, 10.27], which indicates a gap between responses in survey A and responses in survey B for these questions.

In the interviews, when answering survey A and survey B in conjunction with trips they did, some participants realized their responses in survey A and their responses in survey B did not always agree with each other. That is, they realized they often ended up doing

something else than the original plan. Moreover, one of the participants noticed he tended to be in more exposed terrain than he had originally intended:

> *I noticed I said I would avoid run-out zones and release zones above 30 degrees but then, when I answered those questions afterwards, I saw that we actually had been in more dangerous terrain than we- or than I intended. So yeah, it's easy to deviate from what's decided ahead of time. (male, early twenties)*

Overall, the quantitative data indicate a tendency for participants to not do (survey B) what was intended (survey A), which was supported by the qualitative findings in which some of the participants realized their conducted trips deviated from their original plans.

Evaluation of the project. In the interviews, when the participants were asked about what participating in this project had been like, the participants' main responses were that answering questions before and after trips contributed to a heightened sense of awareness of the whole aspect of recreation in the backcountry – from planning, conducting and to evaluating trips. Through answering survey A, they were reminded of what they should be thinking about, such as having a plan that matched the avalanche warning and weather forecast, and who they were going with. One participant found it particularly valuable in that it remined him of factors he would not normally think about:

> *I've especially become more aware of the external factors that my group comes with. I think it's very important to be reminded of all the factors that the questionnaire has come up with just before you go on a trip, because just before you go for a trip, all are excited, the weather might be really good and you just have to hurry off, and no one is watching avalanche videos in the morning. Of course, you check the avalanche warning and the weather forecast, but these are things you already do in a way. But if you get this questionnaire that reminds you of the many things that you know about*

but that you consciously don't really think about, then I think you're more aware of it when you're conducting the trip. (male, early twenties)

Answering survey B contributed to evaluating the conducted trips, and furthermore, answering difficult and technical questions had been particularly valuable for own learning, as one participant said:

The technical questions have been useful in that I have been forced to actually think more systematically through the snow cover, through the different signs, in a more concrete way. So, I think that's been useful for my own learning. (female, early thirties)

That being said, the participants also thought it was easy to forget to answer these questions:

I thought it was hard to remember because I'm so used to just go on the trip. I found it difficult to remember that I need to answer these questions before and the day after. (female, early twenties)

Some participants also pointed out that answering questions such as these pre and post trips could become a mindless routine:

At some point, it becomes a routine, you kind of press the same buttons for okay I basically did the same thing as last time. (female, early twenties)

Overall, participating in the project contributed to a heightened sense of awareness and learning among the participants. However, it was easy to forget and at some point, answering these questions became a routine.

Group dynamics (second main theme in the qualitative findings)

Responsibility and trust. In the quantitative surveys, when asked to rate the statement "Everyone had good knowledge of avalanche danger", the participants gave medium to low ratings. Similarly, when asked to rate the statement "Everyone had a lot of experience in avalanche terrain", the participants gave medium ratings. See Table 7 for summarized results.

Table 7
Scores Regarding the Group Interactions and Skill

Before trips (survey A)	**N**	**M**	**SD**
One person planned the trip	92	4.0	1.9
Everyone had good knowledge of avalanche danger	93	3.8	1.3
Everyone had a lot of experience in avalanche terrain	94	3.5	1.1
The groups skills, experience and competence	65	3.8	1.1
After trips (survey B)			
Everyone discussed the avalanche danger	94	4.3	1.8
We discussed alternative route choices	93	4.1	1.7
Everyone agreed in route choices	95	5.0	1.2
One person made the decisions regarding route choices	95	3.5	1.7

Note. Statements ranged on a 6-point Likert-scale, where scores ranged from 1 (strongly disagree) to 6 (strongly agree)

These results provide a context to the qualitative findings, as those who were knowledgeable and experienced in avalanche terrain typically had more responsibility and more of a leadership role within the group. Many participants trusted their more knowledgeable friend's evaluation of avalanche danger, even when they themselves were unsure about the safety, as one participant said:

> *One of them holds courses in avalanche danger so there are few times I feel as safe as when I'm with him, even though I'm thinking 'oh this is a bit scary'. (...) Because I know they know a lot more and they know we are safe and because they take, what should I say, more complex evaluations. (male, early twenties).*

On the other end, being the one who had such responsibility could be difficult, as another participant expressed:

> *Responsibility is scary especially since it's not always easy to know whether your decisions have been good or not. (male, early twenties).*

Interestingly, many of the participants realized after having learned more themselves, that those who were more knowledgeable and experienced did not necessarily know best or make the safest decisions, as one participant told:

> *I've previously trusted my dad a bit blindly because I know he's been skiing a lot and he said he doesn't take me on something he knows isn't safe. I think I've trusted that very much before but as I've started to learn more I've started to ask him some control questions (...) I remember we were in the Alps and I saw there were some avalanches from time to time happening in particular slopes and sides and then my dad started saying 'oh look at those sides, we have to ski there' but then I was like 'hello, look at the avalanches that go in similar type of terrain, I'm not going with you there. (female, early twenties)*

When the group had no distinction in competence and experience, confusion around who were leading could occur. That is, mindlessly walking behind someone could lead to a shift in responsibility that was not expressed out load, making the responsibility and decisions hang in the air without the group being aware, as one participant said:

> *I think it's easy sometimes to forget that you have to think for yourself and not just follow the first person. (...) For that is a well-known thing that can become dangerous, that nobody has that responsibility and those who go behind only go behind, and those who go first think that those who go behind will say something (female, early twenties).*

Overall, the quantitative self-reported responses indicate that the group's members were moderately knowledgeable and experienced, and the qualitative findings showed how knowledge and experience would shape different group roles. Responsibility and leadership within a group depended on experience and knowledge of the group members, in which those who had leadership-roles usually were given trust. However, blind trust could become an issue if the leader begins to make erroneous assessments. Groups with no distinction in experience and knowledge of the different members had no typical leader, which could lead to confusion around leadership.

Group interaction. In the quantitative surveys, when the participants were asked to rate different statements pertaining to group interactions such as “Everyone discussed avalanche danger”, “We discussed alternative route choices” and “Everyone agreed in choice of route” the participants gave medium to high ratings. These high ratings indicated that the participants had good group processes and interactions, particularly regarding agreement. See Table 7 for details.

In the qualitative interviews, participants expressed that discussing avalanche danger was an essential part of the trip. Fruitful, dynamic dialogues occurred when the participants were with people who had similar level of knowledge and experience, in which they would play on each other’s knowledge and competence and learn from each other. One participants explained this interaction as follows:

> *If I think about the friends that I like to go backcountry skiing with, then that discussion about gathering info and evaluating pros and cons and such is a natural part of the conversation. (...) A bit back and forth like, I see this, what do you think? (female, early thirties)*

In such groups they made the evaluations of avalanche danger together, deciding jointly on where they would go. Moreover, when disagreements arose, they were good at talking through their different opinions, reaching agreement in the end.

In contrast, some participants would rarely discuss avalanche danger if they were out with someone who did not know as much, in which they would make the decisions themselves:

> *It depends on who I’m with, if I’m with someone who’s very inexperienced, then, I don’t know, I don’t feel like mentioning it (...) Of course, if there’s something important that I’ve noticed then I’ll say so. (male, early twenties)*

Moreover, one participant expressed that having people who disagreed with him regarding safety was particularly challenging in such groups:

> *I often think about how I should, in a way, present it better if I notice that people don't fully agree that it might be dangerous to go somewhere (...) It's much easier if they have the same knowledge, then they more easily understand what I mean, but if I'm out with four buddies who know nothing about snow and just want to ski, that's much harder" (male, early twenties).*

Overall, the quantitative results indicated a trend in which everyone in the group partake in discussions of avalanche danger and where to go, and the group agreed in the decisions made. The qualitative findings shed further light on what this interaction might look like, in which similar levels of knowledge and experience were key elements in order to have good group discussions and evaluations of the avalanche danger. Groups with members that did not know as much of avalanche danger, discussed the avalanche danger to a much smaller extent and disagreements could be more challenging to solve.

Group influence. In the qualitative interviews, participants talked about how being in a group could be challenging. Peer pressure was a topic multiple participants brought up, and one participant in particular told of an incident where he and his group triggered an avalanche, which he reflected around in the interview:

> *It was really embarrassing that I became victim to something that was, yeah, textbook stage. Both in relation to what the conditions were, the feedback we got from the snow cover, how poor visibility we had and how the weather was, but also, it was one of those trips where I didn't push that much (...) It was kind of interesting how I became relatively concerned about being well-liked and have a profile that I thought would fit with the other two. I knew they were out a lot and I was interested in finding like-minded people who wanted to go skiing. (male, early twenties)*

Daring to speak up against a group is not a given, particularly not if the others are insisting, have very firm opinions and/or are more experienced. Simply agreeing might be the easiest option, as another participant said, when she talked about group interactions in which some people are perceived to be more knowledgeable:

> *It's very easy to just say 'yeah but I agree with you'. Agreeing causes very little friction in a way. (female, early thirties)*

Overall, conflicts can arise in groups who have differences in motivation and risk acceptance and wanting to impress or daring to speak up against more experienced people is not easy.

Individual cognition and behaviour (qualitative main theme number three)

Personal risk acceptance. In the quantitative results, the participants rated different factors, such as weather conditions, snow cover and such to be quite safe, and this was true both before (in survey A) and after trips (Survey B). See Table 8 for an overview of the results.

Table 8
Scores of General Factors and Conditions Before and After Trips

Before trips (survey A)	**N**	**M**	**SD**
How favourable do you consider the weather conditions to be?	65	4.3	1.0
How manageable do you consider the snow cover to be?	64	4.1	1.0
How safe do you evaluate this trip to be, based on avalanche danger, plan, group and terrain?	69	4.9	0.9
After trips (survey B)			
How safe did you consider the terrain to be regarding avalanches?	66	4.5	1.0
How safe did you consider terrain over 30 degrees to be?	45	4.5	1.0
How safe did you consider the run-out sones to be?	62	4.7	0.9
How confident were you in route choice regarding avalanche risk?	63	4.7	1.0
We made good evaluations of the avalanche danger?	93	4.6	1.1

Note. Statements ranged on a 6-point Likert-scale, where scores ranged from 1 (strongly disagree /very unsafe /low) to 6 (strongly agree /very safe /high)

In the qualitative interviews, the participants had mainly a low risk acceptance and tried to minimize their own risk exposure. Particularly one participant was very aware of the potential risk of being in avalanche terrain, as he said:

> *I'm relatively conservative, it's not very often I decide that I want to go out knowing I'm exposing myself to big nasty sides that are high in consequence. I find it uncomfortable as long as there's a possibility that I can be taken in an avalanche. (male, early twenties)*

In contrast to the others, one participant expressed he would sometimes choose the riskier yet more fun option of skiing in untracked snow in steeper and more uncertain terrain:

> *I don't remember whether it was exactly thirty degrees where I turned right but in my head it was thirty degrees, and that's probably the most important thing I suppose, that I think there might be an avalanche, but still choose to ski there. Yeah, because that snow looked so good and it was a little steeper and more exciting and more fun. (male, early twenties)*

Overall, both quantitative results and qualitative findings indicate that the participants do not go into avalanche terrain if the risk is high, and they do not wish to be unnecessarily exposed. However, choosing the safest option might not always be so easy.

Motivation, goals and risk awareness. In the interviews, the participants' main motivation behind their trips were skiing in nice powder snow, preferable where it was steep. Thus, an important part of the trip was finding the best skiing conditions:

> *It's an assessment of avalanche danger but it's also an assessment of where the good skiing conditions are, right? So, it's a combination. (female, early thirties).*

After reaching the top, the anticipation of downhill skiing became the main focus in many of the participants:

> *Of course, you get excited at the top, and you just want to ski, I love skiing. (female, early twenties)*

Interestingly, being out skiing could sometimes overshadow their awareness of avalanche danger, as one participant said:

> *You're so well into the trip that you might forget it a bit. (...) I often think about it when I go up, I often forget it while skiing down. And maybe you ski down another side and it all happens so fast that you somehow, yeah. You might not evaluate it as good. (male, early twenties)*

Moreover, beginning to think that the hazard is not that large after all was also evident among the participants, as one participant said:

> *It looks so harmless when you're out there, you just can't understand that it might be something. It just feels so unlikely that something will happen. (male, early twenties)*

Overall, skiing in nice powder snow in steep terrain was a main goal for many of the participants, which in some cases could make them less aware of the avalanche danger, or in some cases, underestimate the risk.

Previous experiences. Half of the participants in the interviews told of avalanche related incidents they had experienced in avalanche terrain, and where they after this event became more aware and concerned of the risks and hazards that come with being in avalanche terrain. One participant reflected around how such an experience had changed her and her risk acceptance:

> *I'm very selective about who I go out with, and group size, and I have a very low threshold for saying that I don't agree, I won't bother with this. (...) I'm probably a lot more uncompromising than I was before. I used to be much more like 'we're a nice bunch and there are five more coming but oh well, the atmosphere is good', while now*

it's more like 'that's out of the question'. I'd rather them think I'm lame" (female, early thirties).

Overall, previous, negative experiences in avalanche terrain affected the participants and their acceptance of risk.

Discussion

This study aimed to investigate how backcountry recreationalists plan, conduct and evaluate trips in avalanche terrain. The participants gathered relevant information before trips and they had favourable behaviours regarding avalanche safety and the participants did not wish to enter avalanche terrain if the risk was high. Our findings further illustrated how both social and personal factors affected behaviour when recreating in avalanche terrain. Moreover, our findings indicate an intention-behavior gap among the participants. Evaluating after trips were not common among the participants, however, participating in the project seemed to have had an positive effect in which thinking through the trip contributed to greater awareness and learning. Due to comprehensive results and findings, the following discussion will focus on the following important aspects: (1) the intention-behaviour gap, (2) the influence of competence and experience and (3) how the concept of answering questions before and after trips can contribute to learning in avalanche terrain.

Intention – behaviour gap (1)

Although the quantitative results should be interpreted carefully, the tendency for participants to not do what they intended, together with our qualitative findings of participants realizing their conducted trips deviated from their original plans, indicates an intention-behaviour gap in our sample of participants. Studies indicate that detailed planning, along with self-efficacy and self-regulatory strategies, in itself might bridge the gap between intention and behaviour (Sniehotta et al., 2005). In this study, the participants had, through answering survey A, been 'forced' to plan to a greater extent than they perhaps would have in a normal, everyday situation, in which their intention might have become clearer. Moreover,

the fact that participants were asked to answer questions before a trip might also have caused the participants to remember what they planned. Therefore, the gap might be even bigger among backcountry recreationalists in general, in which plans might been as extensively formulated as they have been in this project.

This gap might be explained by several factors. When conducting trips, the participants would adapt their trips based on observations of avalanche danger and cancel if there were clear danger signs or complex terrain. Thus, local variations of avalanche hazard might make them conduct a different trip than they had first intended. After all, being overly committed to a pre-existing plan is not ideal in these ever-changing conditions. In particular, among the participants, choice of route would often depend on observations of avalanche danger. The quantitative results also indicated that observations and/or tests and safe behaviour tended to be less than planned. One explanation might be that the actual route had been safer than the planned route, in which conducting tests, observations and different safety behaviours might be excessive. However, this gap could also be caused by social and personal influences in which the participants ended up taking greater risks than they intended. This was evident in the participant who often ended up going in more exposed terrain than he had intended. Similar to other studies, our results indicate multiple human factors that influenced behaviour and can help explain why risk exposure might become greater than the original intention.

Cognitive biases and heuristic traps. Although participants expressed being aware of avalanche danger while also enjoying the sport, there seemed to be a distinct shift in some of the participants' focus once they reached the top of the mountain. Noticeably, for some of the participants, the anticipation and excitement of downhill skiing would then become more emphasized while awareness of avalanche danger became second place. This was particularly evident in the participant who expressed he was mostly finished with the avalanche danger

assessments once he reached the top, and in the participant who tended to forget about avalanche danger while descending. This is particularly troublesome if they would decide on descending a different side than the one they walked up. Our findings further illustrated that choosing the safest option might not always be so easy, which was evident in the participant who would ski in more uncertain terrain if the snow there was good. The heuristic trap called 'tracks', argue that recreationalists are more likely to ski an untracked slope in nice powder snow (Furman et al., 2010; McCammon, 2004a). Thus, choosing good snow quality and/or untracked snow over a safer snowpack is a common heuristic trap among recreationalists which might cause greater exposure to avalanche danger than intended. Moreover, experiencing a false sense of security and underestimating the danger are other cognitive biases and heuristics traps that were evident among our participants. Being overly optimistic and thinking the hazard is not that large after all, or thinking the snow looks harmless, might make an individual move into more exposed terrain. The positive and rewarding experiences of successfully descending slopes can furthermore lead to an illusion of good skills, and can contribute to overconfidence and excessive risk-taking (Bonini et al., 2019; Sanchez & Dunning, 2018). However, competence pertaining to avalanche hazard might not increase at the same rate as competence in downhill skiing.

Social influences. Positively, the quantitative results indicated that the group processes were good, which was, for instance, evident in the high level of agreement of the decisions made. However, there were exceptions to the rule and our findings illustrate the strong mechanisms that are at play when groups are out in the avalanche terrain together. Conflicts and disagreements could occur when group members had different understandings of the risks. If conformity pressures become so strong that individuals stop contributing their opinions, or simply agree, the group might fall into groupthink (Hogg & Hains, 1998; Whyte, 1998). This was evident in the participant who expressed difficulty in convincing his buddies, who just

wanted to have fun skiing, of what was safe and what was not. Being against the majority's opinion in groups is a difficult situation and complying might become the easiest option. Moreover, the heuristic trap of social facilitation, which argues that people will attempt to take greater risks when others are present, and the heuristic trap of acceptance, that is, engaging in activities that will get them noticed (McCammon, 2004a), were evident in the participant who wanted to be liked by the other two in the group despite getting a bad feeling. Group conformity, groupthink and peer pressure have all been identified as important factors that can lead to excessive risk-taking (Hogg & Hains, 1998; Kerr & Tindale, 2004; Whyte, 1998), and have gotten people into trouble in avalanche terrain time and time again (Tremper, 2008, p. 283). Such group processes can certainly lead to greater exposure than the intention. Furthermore, group factors have been rated as problematic in other studies (Engeset et al., 2018), confirming that group dynamics in avalanche terrain might be difficult to manage.

According to our findings, the level of skill and competence was of particular importance for those who were given leadership within a group. In groups with different levels of competence, the person with most knowledge and experience typically became the leader, whereas groups who had an even balance of competence among the group members would often not have an appointed leader. According Zweifel and Haegeli (2014), single leaders with avalanche expertise or multiple leaders where leadership responsibilities are divided up according to their specific skills, will be favourable for avalanche safety. However, as some of the participants in our study realized, having an appointed leader could lead to greater risk exposure if the leader made erroneous judgements of the avalanche danger. This corresponds with the 'expert halo', another heuristic trap identified by McCammon (2004), that argues that an overall positive impression of a leader can cause individuals to ascribe the leader with skills he or she might not have. Similarly, Zweifel and Haegeli (2014) note that the leader is not always the most qualified person. In the avalanche safety literature, following

blindly whoever is leading has repeatedly gotten many people into trouble and has been labelled the 'sheep syndrome' (Tremper, 2008, p. 254). Yet, being a beginner, it can be difficult to know whether a leader is making erroneous avalanche assessments, or sound ones.

The level of skill and competence further determined interaction within the group. Our results indicated that groups with even balance of knowledge among the group members were better at communicating as they throughout the whole trip would exchange information and points of view and make the assessments together. However, if the group did not engage in such discussions, they might run the risk of misunderstandings around leadership and the group's performance might be diminished. Moreover, the group could have high overall competence but it might not be used fully if the role of the leader, consciously or not, was entrusted to only some individuals. Having group members who were less knowledgeable could, however, lead to a group interaction in which they did not discuss avalanche danger and where the leader would be left to do the decision-making. Minimal communication can enhance human error and subjective biases, which can lead to poorer performance of the group (Adams, 2005; Zweifel & Haegeli, 2014).

Influence of competence and experience (2)

The importance of experience. Throughout our findings, the participants had different approaches to planning, conducting and evaluating trips, and there was a clear distinction in how the different participants talked about avalanche danger. Such differences could be explained by differences in past experiences, as well as different levels of knowledge and competence regarding avalanche safety. Through many years of trial and error, experts have valuable past experiences that guide present behaviour (Tremper, 2018). In contrast, beginners lack essential experiences, which was noticeable in the qualitative interviews. The participants who told of previous, negative experiences of avalanche related incidents were also those who expressed a certain carefulness and concern for avalanche danger throughout

the interviews. Those who did not mention any experienced negative incidents had more adventure seeking statements and expressed less concern for avalanches. This difference can be exemplified by the young male who did not wish to expose himself to slopes high in consequence, and who told of the incident where the avalanche was triggered, and the young male who was testing limits and skiing in uncertain terrain. Some things cannot be learned exclusively on the basis of descriptions (Hertwig et al., 2018). Thus, there is a difference between learning the consequences of avalanches from personal experience and learning from description. Negative experiences leave a lasting impression that affects present behaviour to a greater extent. As Tremper (2018, e-book location 5666) notes, it is first after a first close call or the death of a friend in an avalanche that confidence falls to a low, and then slowly, through more experience and knowledge, rises again, however not to the same extent as before. The participant who experienced the avalanche incident with the two buddies, will probably not put himself in a similar situation again.

Such differences in experiences and knowledge further reflected the different approaches our participants had to planning and conducting trips. For instance, when reading the avalanche warning, the participants differed in how the information was interpreted and used. In the interviews, some participants described themselves as beginners, which explains why some of them expressed not fully understanding the information in the avalanche warning or relying too heavily on the avalanche danger level. In contrast, those who described themselves as relatively competent and experienced were also those who would read about the avalanche problems. These findings are compatible with Hallandvik et al. (2017) who found that novices ranked the avalanche danger level highest among the different items in the avalanche warning, while experts ranked the avalanche problems as the most important and the danger level as least important. Other studies find similar trends (Engeset et al., 2018; Furman et al., 2010). Another factor that could explain such differences is that experiencing

an avalanche is considered a low-probability event (Tremper, 2018), thus, recreationalists might not prioritize the time and effort in learning the technical terms in the avalanche warning, and instead rely on the avalanche danger level. The difference in experience and knowledge could furthermore be found in the extent of detail in their plans. Some participants used steepness maps, trying to find the most appropriate route before leaving home, whereas others had an overarching plan that took form as they were out in the terrain and could see for themselves how the conditions were. This difference further illustrates the difference between beginners and experts.

Skiing in familiar terrain. An important finding in our study was how variation in planning and conducting trips depended on whether they were entering familiar terrain or not. Planning of trips in familiar terrain could for instance lead to less preparing before the trip, and moreover, as one participant pointed out, taking the same type of trip many times could become a routine which could make her more unaware while conducting the trip. Past actions might guide present behaviour in familiar settings, which corresponds with the familiarity heuristic (McCammon, 2004a). Not being as aware because they know the trip and think it looks similar to another successful day, could become a risk in itself as avalanche hazard is dependent on a number of integrated factors that change over time and place (Landrø et al., 2020). Moreover, Furman et al. (2010) found that familiarity increased the likelihood of skiing a slope among backcountry recreationalists (Furman et al., 2010). As different conditions can make the same trip quite safe one day and hazardous another day, being alert is critical and staying vigilant is essential in order to mitigate risks, particularly in familiar terrain.

Learning through planning and evaluating (3)

Promisingly, the participants' feedback on the project was positive as they found that thinking through the trip and evaluating what they had done and how the conditions were, contributed to learning. Moreover, there was learning in seeing that the conducted trip might

have deviated from the plan. Thus, planning and evaluating trips this way could create a procedure that contributes to purposeful, systematic and deliberate practice. Moreover, the fact that the majority of our participants would rarely evaluate their completed trips, unless something negative happened, indicates the potential of enhancing learning outcomes through evaluating trips among recreationalists, also for trips that seemingly went just fine. Importantly, answering questions this way had the positive effect of re-focusing people's attention. That is, the participants found that answering these questions contributed to a heightened sense of awareness while conducting trips. As such, this concept might contribute to improve safety in the potential routine task of planning and conducting trips, particularly if the trip is in familiar terrain. Moreover, the fact that this concept contributed to heightened situation awareness, indicates it can function as a checklist-approach, similarly to aviation. In aviation, checklists have proved to be effective in enhancing situation awareness in routine tasks in a high-risk environment and thereby help reduce human error (Aadland et al., 2017; Jones et al., 1996). Moreover, use of more checklists has been proposed to be a valuable tool in preventing avalanche accidents (Tremper, 2018, e-book location 5788).

It should be noted, however, the potential limitations of this concept. Answering the same surveys with the same questions a couple of times could in itself become repetitive, as one participant pointed out. Routines can be good, but if there is a mindlessness to the task, the potential for learning will probably be reduced. The finding that the participants were quite confident in own assessments of avalanche danger in the surveys whereas they in the interviews expressed difficulty in evaluating their avalanche danger assessments, is interesting. The different contexts in which this question was answered could perhaps explain this difference. In the quantitative surveys, questions were probably answered fairly quickly, perhaps in a state of euphoria, and quite recently after the trip, whereas the interviews took place long after their last ski-trip and entailed slow, more focused reflection. Of course, the

participants could also have felt that they truly made good decisions, even if they reflected on it in a slow, deliberate manner. However, for many of our participants in the interviews, more doubt and insecurity regarding own ability to assess avalanche danger became evident. After all, avalanche terrain is a wicked learning environment and it is difficult to know whether decisions were good or not. Therefore, answering survey A and B will not necessarily contribute to deliberate, reflective and critical thinking if they are answered in a rush or if it becomes a mindless routine. Moreover, subjective and affective reflection can in itself contribute to erroneous learning and overconfidence (Hertwig et al., 2018), in which the learning outcome would be questionable. This illustrates the need for time and slow thinking in order to learn (Ericsson et al., 1993). Another important factor is that, contrary to aviation in which pilots are obliged to use checklists, use of checklists and decision-making tools in the backcountry is voluntary and, as pointed out by our participants, easy to forget. It is therefore critical that checklists and decision-aids are simple and easy to use. For instance, checklists with many different questions, which have the advantage of more thoroughness, will probably not be particularly useful among recreationalists in avalanche terrain as they would be more time consuming and complicated to use, and thereby less likely to be used. Therefore, reducing the number of questions would probably be more beneficial for this concept. Moreover, having a checklist that is accessed through smart phones, opens doors to more creative solutions. For instance, to help prevent it from becoming a mindless habit, or boring after some time, the wording of questions could be different for each time the survey is entered, and furthermore, use of animations and figures could make it more appealing and interesting to use.

Implications

Most educational courses focus on teaching the fundamentals of snow and avalanches and how to find good and safe routes and select terrain based on conditions and competence.

Although it has been argued that simply making backcountry skiers aware of human factors might not make them less susceptible to them (McCammon, 2004a; Zweifel & Haegeli, 2014), teaching recreationalists about human error does help (Tremper, 2018, e-book location 5906). Therefore, backcountry recreationalists should also learn about how personal motivation and group dynamics might affect their trip in such a way that they might end up going in more exposed terrain than they perhaps intended. Moreover, in order to avoid misunderstandings and miscommunications, avalanche educators should emphasize the importance of having a group discussion before the trip begins, in which the group's goal, leadership and such is discussed. In order to prevent blind trust, asking each other questions, or asking the leader questions so that he or she needs to reason out load might help in both preventing subjective biases and in engaging everyone in the group.

Although the concept of planning and evaluating trips has its disadvantages similar to other decision-making tools and checklists, the positive feedback on the project indicate a positive potential. Answering different questions before and after trips contributed to both learning and situation awareness. Heightened situation awareness is particularly promising given our finding of how familiarity and habits might contribute to automatic thought processes in which people become more unaware of important information from the terrain. As such, if it is adapted to be more user friendly, planning and evaluating trips this way has the potential to become a valuable addition to existing decision-making tools and checklists.

Limitations and future research

There are some limitations of the present study that should be noted. The sample size was relatively small and not necessarily representative of backcountry recreationalists as a whole. Therefore, our results should be interpreted as exploratory rather than confirmatory. Moreover, our study relied on self-reports in which the same participants could answer the surveys for as many trips as he or she wished, which might have affected the quantitative

results. It should furthermore be noted that the participants feedback on the project were given in the interviews. Giving negative criticism can be difficult face-to-face, thus, there might be a potential disproportion between the positive feedback and the negative feedback. However, it was emphasized that critical feedback would be essential in order to make improvements, and the participants were encouraged to be honest.

Despite these limitations, our findings provide a good foundation for future studies that investigate similar or related phenomena. Future studies should further research the intention-behaviour gap in bigger samples of backcountry recreationalists and clarify further the different factors that might contribute to this gap. Better understanding of the factors that might contribute negatively to the gap and identification of measures that might help bridge the gap, can help reduce loss of life in avalanche terrain. Furthermore, it could be useful to investigate the effects that answering questions before and after trips might have on learning and situation awareness.

Conclusion

In a broad sense, the goal of this thesis was to enhance safety in avalanche terrain by increasing our understanding of how backcountry skiers plan, conduct and evaluate trips. Integrating both quantitative and qualitative data proved useful to explaining our findings, and our study has given good insight into the different processes involved when trips are planned and conducted, and the factors that might influence these trips. Planning and gathering essential information from the avalanche warning was essential, however, interpretation of the information and degree of planning depended on knowledge and experience among the participants. Moreover, there was a difference between what the participants planned to do and what they actually did. In order to mitigate risks in avalanche terrain, changing plans proved to be essential in this ever-changing environment. However, the participants would also change plans due to both personal and social factors. Personal motivation, cognitive

biases and heuristics could move their attention away from avalanche safety and toward the enjoyment of downhill skiing. Social factors such as peer pressure, poor communication and blind trust could furthermore lead to greater exposure to avalanche risk. Knowledge about the influence of human factors on behaviour in avalanche terrain might be useful to identify mitigating actions that can help reduce this gap. Our findings further revealed how answering questions before and after trips could contribute to a reflection they would not have done otherwise. Moreover, answering questions before and after trips has the potential to become a useful tool that can contribute to learning from trips and heightened situation awareness while conducting trips.

In sum, this thesis has pointed out important factors that are involved in the complex process of planning and conducting trips in avalanche terrain and highlighted how planning and evaluating trips in a structured way, along with other measures, has the potential to help reduce loss of life in avalanche terrain.

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APPENDIX A

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKT

En studie om læring og risikoforståelse i skredterreng

HVA INNEBÆRER PROSJEKTET?

Dette er en forespørsel til deg om å delta i et forskningsprosjekt som omhandler læring og risikoforståelse i skredterreng. Siden du allerede har svart på spørsmål før og etter tur gjennom RegObs Turlogg ønsker vi å intervjue deg i forbindelse med de turene du har gått. Mer spesifikt ønsker vi å snakke om dine tanker rundt det å planlegge og evaluere tur. Deltakelse forutsetter at du kan sette av en time til intervju.

Prosjektet vil innebære lydopptak, og det antas at intervjuet vil vare i en time. Intervjuet vil så bli transkribert - skrevet ut i tekst.

Det transkriberte intervjuet vil bli analysert og brukt til forskning. I denne studien vil alt av identifiserende informasjon om deg bli tatt bort, og dine utsagn vil bli anonymisert. Resultatene av denne studien vil bli presentert i en masteroppgave og senere også i en vitenskapelig artikkel.

Prosjektet er i samarbeid mellom Norges Vassdrags- og Energidirektorat (NVE) og Center for Avalanche Research and Education (CARE) ved UiT Norges arktiske universitet. Ønsker du mer informasjon om prosjektet, kan du ta kontakt med:

- **Ingrid S. Haarberg**, masterstudent ved institutt for psykologi, UiT. Det er Ingrid som kommer til å gjennomføre intervjuene.
  Mail: XXX Mobil: XXX
- **Audun Hetland**, CARE / førsteamanuensis ved Institutt for psykologi ved UiT
  Mail: XXX Mobil: XXX
- **Rune Engseth**, seksjonssjef i NVE og tilknyttet CARE.
  Mail: XXX Mobil: XXX

MULIGE FORDELER OG ULEMPER

Ved å delta på i dette forskningsprosjektet kan du bidra med veldig viktig innsikt i hvordan mennesker planlegger, evaluerer og lærer å håndtere skredterreng. Dataene fra dette studiet vil også brukes for å se om vi kan utvikle en app som kan gi tilbakemelding til mennesker som ferdes i skredterreng.

Dette vil innebære få eller intet ubehag eller risiko, og deltakelse får ingen konsekvenser for studiested eller arbeidsgiver. Dataene om deg vil bli holdt anonym.

FRIVILLIG DELTAKELSE OG MULIGHET FOR Å TREKKE DITT SAMTYKKE

Det er frivillig å delta i dette prosjektet. Du kan når som helst, og uten å oppgi grunn, trekke ditt samtykke. Dersom du trekker deg fra prosjektet, kan du kreve å få slettet innsamlede opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner. Dersom du senere ønsker å trekke deg eller har spørsmål til prosjektet, kan du kontakte Ingrid Stette Haarberg eller Audun Hetland.

HVA SKJER MED OPPLYSNINGENE OM DEG?

Du har rett til innsyn i hvilke opplysninger som er registrert om deg og rett til å få korrigert eventuelle feil i de opplysningene som er registrert. Du kan be om å få en transkripsjon av intervjuet etterpå for å bekrefte, klargjøre eller ta bort noe av innholdet dersom du ønsker det. Du har også rett til å få innsyn i sikkerhetstiltakene ved behandling av opplysningene.

All informasjon vil bli behandlet og brukt uten ditt navn eller personlig identifikasjons-nummer eller annen informasjon som er direkte identifisert til deg.
Opplysningene om deg vil bli anonymisert eller slettet senest 04 mai 2020. Selve lydopptakene vil da også bli slettet.

SAMTYKKE

JEG SAMTYKKER TIL Å DELTA I PROSJEKTET

_____	_____
Dato og signatur fra deltager	**Deltagers navn skrevet med blokkbokstaver**

APPENDIX B

Intervjuguide

Aller først (litt bakgrunnsinformasjon):

- Hvor mange toppturer går du sånn ca. i løpet av en sesong?
- Pleier disse turene å gå i skredterreng?
- Pleier turene å gå i løsneområder for snøskred (over 30 grader)?
- Hvor erfaren vil du si at du er? (nybegynner, gjennomsnittlig, erfaren, ekspert)

DEL 1

Du har i løpet av den her vinteren snart på spørsmål før og etter tur - spørsmålene før tur har i hovedsak handlet om hva du planlegger å gjøre på tur, også har du evaluert turen du har vært på gjennom spørsmålene du svarte på etter turen. Nå vil jeg forstå mer om hvordan du generelt forbereder deg til topptur på vinteren og hva du sitter igjen med av læring etter hver tur.

Mens du er hjemme: Pleier du vanligvis å planlegge før tur i skredterreng? (/eller kan du være spontan og bare dra på tur?)

- Hvis ja, spør: Kan du fortelle om hvordan du pleier å planlegge en tur?
- Hvis nei: Hvorfor ikke?

- Pleier du å innhente noe informasjon om forholdene før turen?
- Sjekker du skredvarslinga?
  - Hvis ja: Hvilke aspekter i skredvarslinga pleier du å sjekke ekstra nøye?
  - Hvis nei: hvorfor ikke?

- Har du avlyst en tur i planleggingsfasen?
  - Hvis ja: Fortell hva som skjedde?
  - Hvis nei: Hva er det som skal til for at du avlyser på grunn av for høy risiko?

- Er det noen forhold i skredvarslinga som gjør at du avlyser en tur i skredterreng? I så fall hvilke?

I bilen – Så nå har du satt deg i bilen og kjører til fjellet/området du har tenkt deg til. Gjør du noen vurderinger i denne delen? (/innhenter du noe informasjon i denne delen?)

- Har du noen gang endret planer i bilen?
  - Hvis ja, kan du fortelle hva som skjedde? (/hvorfor?)

- Har du noen gang avbrutt turen på dette stadiet?
  - Hvis ja: kan du fortelle hva som skjedde?

- Hvis nei: hva må til for at du endrer planer når du har satt deg i bilen?

På parkeringsplassen – Du kommer frem til parkeringsplassen og gjør deg klar til tur. Gjør du noen vurderinger her? (/samler du noe informasjon?)

- Har du noen gang endret planer når du har kommet til parkeringsplassen?
    - Hvis ja, kan du fortelle hva som skjedde / hvorfor?

- Har du noen gang avbrutt en tur på parkeringsplassen?
    - Hvis ja: kan du fortelle hva som skjedde?
    - Hvis nei: hva må til for at du endrer planer her på parkeringsplassen?

På ski – Du har tatt på deg skia og er klar til å gå. Hvordan forholder du deg til skredfare underveis?

- Ser du etter noe?
- Gjør du noe?
- Pleier du å gjøre noen observasjoner eller tester?

- Diskuterer du skredfare med de andre du (eventuelt) er på tur med?
    - I så fall hva? Når diskuterer dere dette?

- Har du noen gang snudd og gått tilbake igjen?
    - Hvis ja, kan du fortelle om en gang dette skjedde?
        - Hva tenkte og følte du?
        - Fikk du noen varsler?
        - Hvordan oppdaget du eller dere dette?
    - Hvis nei, hva skal til for at du snur på vei opp?

På toppen – Du er endelig på toppen. Hvordan forholder du deg til skredfare nå?

- Gjør du noe før du kjører ned?
- Ser du etter noe?

- Har du noen gang endret planer på toppen?
    - Hvis ja, kan du fortelle om en gang det skjedde?
    - Hvis nei, hva skal til for at du endrer planer på toppen?

På vei ned – Hvordan forholder du deg til skredfare på vei ned igjen?

- Ser du etter noe?
- Gjør du noe?

Du er tilbake i bilen igjen og turen er ferdig – Evaluerer du turen i etterkant?

- Pleier du å tenke over beslutningene du tok på turen? I så fall, hva tenker du over da?
- Pleier du å tenke over snøskredfaren i etterkant av en slik topptur? I så fall, hva tenker du over da?
- Pleier du å trekke læring av turen på noen måte?

- Kan du huske en bestemt gang du ble sittende å evaluere en tur du har vært på i etterkant?
    - Hvis ja, kan du fortelle om en gang dette skjedde, hva var det som skjedde på denne turen?
    - Hvis nei, hva må ha skjedd på en tur for at du skal evaluere den i etterkant?

DEL 2

Så til den spesifikke turen du gikk den (dato og sted)

- Kan du fortelle om turen?
    - Mulige probes: Planla du noe før turen? Hvordan var forholdene? Hvem var du med / var du alene? Lang tur / kort tur?

- Du hadde noen bilder? Kan du fortelle?

DEL 3

Okei, da går vi videre, nå ønsker jeg å høre mer om dine tanker om selve prosjektet. Du har vært med på prosjektet via Varsom hvor du har svart på spørsmål før og etter tur

- Hvordan har det vært å svare på disse spørsmålene før og etter tur?
    - *(oppmuntre til både kritikk og ros – ønsker ærlig tilbakemelding)*

Her er et ark med de ulike spørsmålene du har svart på før og etter tur *(gi ark med alle spørsmålene brukt før og etter tur)* og som du ser blir det ganske mange spørsmål. Hvis du skulle valgt ut noen få viktige spørsmål som du mener er viktig å reflektere over før og etter tur, hva hadde du valgt?

- Nå begynner det å bli en stund siden, men kommer du på noen andre spørsmål som hadde vært viktig å stille før (og etter) tur (enn de som allerede ble stilt)?

- Hvilken effekt tror du det å svare på disse spørsmålene før og etter tur har hatt? Har det noe effekt?

- Eventuelt, tror du spørsmål ala dette påvirker bevisstheten rundt risikoen ved å være i skredterreng?

Avslutte intervjuet - Da nærmer vi oss slutten på intervjuet og jeg har fått stilt de spørsmålene jeg ville. Har du noen kommentarer eller noe du gjerne vil si til slutt?