PREPUBLICATION VERSION

07.02.2021

Should I Judge Safety or Danger? Perceived Risk Depends on the Question Frame

Matthew B. Stephensen[1], Christin Schulze[2,1], Markus Landrø[1,3], Jordy Hendrikx[4], and Audun Hetland[1]

[1]UiT The Arctic University of Norway, Tromsø, Norway

[2]Max Planck Institute for Human Development, Berlin, Germany

[3]Norwegian Water Resources and Energy Directorate, Oslo, Norway

[4]Montana State University, Bozeman, USA

Open science statement: Data, analysis scripts, and study materials are available at https://osf.io/sknxf/, https://doi.org/10.17605/OSF.IO/SKNXF

Corresponding author: matthew.stephensen@uit.no; matthew.stephensen@gmail.com

Abstract

Linguistic polarity is a natural characteristic of judgments: Is that situation safe/dangerous? How difficult/easy was the task? Is that politician honest/dishonest? Across six studies (N = 1599), we tested how the qualitative frame of the question eliciting a risk judgment influenced risk perception and behavior intention. Using a series of hypothetical scenarios of skiing in avalanche terrain, experienced backcountry skiers judged either *how safe* or *how dangerous* each scenario was and indicated whether they would ski the scenario. Phrasing risk judgments in terms of safety elicited lower judged safety values, which in turn resulted in a lower likelihood of intending to ski the slope. The frame “safe” did not evoke a more positive assessment than the frame “danger” as might be expected under a valence-consistent or communication-driven framing effect. This seemingly paradoxical direction of the effect suggests that the question frame directed attention in a way that guided selective information sampling. Uncertainty was not required for this effect as it was observed when judging objectively safe, uncertain, and dangerous scenarios. These findings advance our theoretical understanding of framing effects and can inform the development of practices that harness question framing for applied risk perception and communication.

Keywords: Framing effect; risk perception; judgment and decision making; attention; avalanche terrain

Public Significance Statement

This study demonstrates that risk judgments framed in terms of safety (*How safe is it?*) result in more cautious, conservative judgments than when framed in terms of danger (*How dangerous is it?*), irrespective of the objective risk of the judged object. These findings advance our understanding of the framing effect while illustrating its particular relevance for applied risk perception practices and for public hazard forecasting and information communication strategies.

Should I Judge Safety or Danger? Perceived Risk Depends on the Question Frame

Framing is a ubiquitous psychological phenomenon that holds much promise for applied risk communication and risk perception. A wealth of empirical findings have shown that the way in which a problem, situation, object, event, or goal is described affects how people respond to or evaluate it (for reviews see e.g., Kühberger, 1998, 2017; Levin et al., 1998; Maule & Villejoubert, 2007; Piñon & Gambara, 2005). Framing effects are traditionally regarded as a deviation from rational behavior (Kahneman & Tversky, 1984; Tversky & Kahneman, 1981). Recognizing the potential problems that framing effects can cause, researchers have investigated numerous methods for debiasing or diminishing framing effects (Almashat et al., 2008; Garcia-Retamero & Dhami, 2013; Sieck & Yates, 1997; Simon et al, 2004). Yet not all instances of framing effects are considered problematic, harmful, or disadvantageous. The purposeful use of framing to promote specific judgments and decisions is an established practice in several fields such as media and communications (Block & Keller, 1995; Chong & Druckman, 2007; Scheufele & Tewksbury, 2007) and marketing (Biswas, 2009; Biswas & Grau, 2008; Levin & Gaeth, 1988). Might the framing effect be similarly harnessed to boost people's natural decision making competencies in order to ensure better, safer risk perceptions? If so, the framing effect has the potential for a real and tangible impact on how people judge risk and, ultimately, how they behave under risky conditions.

In this article, we employ decision making in avalanche terrain as an exemplary case for investigating risk judgments and behavior in domains of applied risk perception and risk communication. Decision making in avalanche terrain represents a paradigmatic case of applied risk judgments and decisions. Avalanche terrain is a highly complex and uncertain decision environment in which judgment errors can result in severe injury or death. Moreover, it is an environment where poor decisions are frequently marked by invalid feedback (cf. Hogarth et al., 2015). A mismatch between perceived risk and reality can therefore be present for even the most experienced decision makers. Nonetheless, skiing in avalanche terrain is an increasingly popular but largely unregulated activity in which people voluntarily engage, most often for purely recreational purposes. Decision making in avalanche terrain provides a paradigmatic case for investigating decisions under real-life uncertainty among an experienced, highly motivated population. Yet the relevance of this research is not limited to backcountry skiing. Frame selection and the strategic phrasing of risk judgments are relevant for a range of disciplines and contexts including police, fire and other emergency services, military operations, the finance sector, work in volatile natural environments such as fisheries, illicit activities such as recreational drug use, and for medical diagnoses and treatment decisions. Decision making in avalanche terrain offers a convenient exemplary case for investigating the effect of framing on risk perception under varying degrees of uncertainty.

One type of framing that appears to be highly relevant for applied risk perception and risk communication is the question frame. Judgments are commonly framed in terms of a single dimension of an integral qualitative attribute of what is judged. For example, "How *bad* is the situation?", "How *expensive* is a product?", or "How *difficult is* an activity?" (as opposed to how good, inexpensive, or easy). Polarity is a natural characteristic of language that constrains and thereby defines the formulation of many judgments to a single dimension of a bipolar attribute (Hilton, 2011). Decision makers therefore naturally employ a single dimension of a qualitative reference such as *safe* or *dangerous* to frame a risk judgment.

Using hypothetical scenarios of backcountry skiing in avalanche terrain across six studies (*N* = 1599), we examined how recreational backcountry skiers evaluated these scenarios when asked to judge *how safe* versus *how dangerous* they are. We also examined how the question frames influenced participants' decision to ski the scenarios. We tested the effect of the question frames on risk perception and behavior intention when judging scenarios of different objective risk levels: scenarios of uncertain risk (Studies 1-6), safe scenarios (Studies 5-6), and dangerous scenarios (Studies 5-6). Based on the existing framing literature, we can expect to find an effect when framing a risk judgment in terms of safety or danger. Beyond that, however, prior research has not established the direction of that question framing effect, the prevalence of that effect under different conditions of objective risk, or the association of that framing effect with behavior intention. How does a qualitative reference frame influence perceived risk? Which of the two frames – safe or dangerous – evokes a more conservative, cautious risk judgment? Is uncertainty a requirement for an effect or does it persist in the face of credible evidence of safety or danger? How does the question framing effect influence behavior, which is ultimately what exposes a person to risk? Different accounts of the cognitive processes underlying framing effects make conflicting predictions about the direction and prevalence of an effect evoked by a question frame. These issues must be resolved in order to determine if it might be possible to harness question framing to promote safer risk judgments and decisions.

Divergent Accounts of Framing and the Direction of the Predicted Effect

Framing effects are diverse and inspire broad theoretical and applied interest in psychology, economics, political science, health sciences, and beyond. Consequently, a variety of heterogeneous phenomena that evoke differing cognitive processes and divergent effects are classified as framing (for reviews, see e.g., Chong & Druckman, 2007; Kühberger, 1998, 2017; Levin et al., 1998; Maule & Villejoubert, 2007). Research on framing in psychology and economics has primarily focused on situations in which different but logically equivalent descriptions lead to different preferences or evaluations, highlighting a violation of the economic principle of invariance (e.g., Tversky & Kahneman, 1981). For example, evaluations tend to be more favorable when a product is described as 90% fat-free than when described as containing

10% fat (e.g., Levin, 1987). This research has traditionally used risky choice framing in which the probabilities of the choice options are differently described (e.g., the classic "Asian disease problem"; Tversky & Kahneman, 1981), and attribute framing in which a single attribute of the target of judgment is differently described (Levin et al., 1998; Piñon & Gambara, 2005). Manipulating the qualitative attribute that frames the question eliciting a judgment (i.e., question framing) has received much less attention in this line of research and has produced mixed results (see e.g., Payne et al., 2013; Comerford & Robinson, 2017).

Research in the fields of political science and health sciences have applied a broader conception of framing in which emphasis on different aspects of an issue leads to different opinions, without necessitating logical equivalence between frames (e.g., Cacciatore et al., 2016; Chong & Druckman, 2007; Druckman, 2001; Bui et al., 2015; Nelson et al., 1997). For example, when asked about government funded financial assistance for people in need, political opinions tend to be more favorable toward government spending if preempted with an emphasis on humanitarian aspects rather than government expenditures (Druckmann, 2001). This broader conception of framing effects is also relevant to survey studies (see Bruine de Bruin, 2011), in which questions with presumed synonyms can elicit inconsistent responses (e.g., Bruine de Bruin et al., 2012) and questions with presumed antonyms can fail to communicate polar opposites (e.g., Holleman, 2006).

The cognitive processes that a frame activates and the direction of the resulting framing effect likely depend on the form and domain in which the frame is achieved. Consequently, several cognitive, communicative, and attentional processes have been proposed for framing effects achieved inside and outside the lab (for a review, see Keren, 2011). These different accounts of framing make somewhat conflicting predictions about how the question frame we tested might affect people's judgment. Does a question about "safety" evoke a more reassuring assessment than a question about "danger" because it triggers a positive connotation or conveys the assumption of safety in the question? Alternatively, does a question about "safety" direct a decision maker's attention to the sparsity of evidence of safety under conditions of uncertainty, thereby prompting a more conservative evaluation? These different theoretical accounts of framing were established and predominantly tested based on risky choice framing and attribute framing research. The extent to which they describe and can predict a question framing effect is presently unclear (see Comerford & Robinson, 2017). By testing the direction of the framing effect evoked when risk judgments are framed in terms of safety and danger, we can infer the cognitive processes that are activated. Because the success of any effort to strategically harness framing in applied contexts depends on correctly matching the type of frame – and the cognitive process that it activates – with the objective for its application, we next review these different accounts of framing in the context of our study.

Valence-driven account of framing effects

One prominent cognitive account posits that framing information in either a positive or a negative way evokes a *valence-consistent* association that influences the selection and encoding of information about the target(s) of judgment (for reviews, Keren, 2011; Levin et al., 1998; Piñon & Gambara, 2005; Teigen, 2015). For example, positively framing an action (75% chance of success) evokes positive associations resulting in more favorable judgments of that action than does negatively framing the same action (25% chance of failure), despite the two frames being logically equivalent. Investigating the valence account of framing in the context of question frames, Payne and colleagues (2013) found that life expectancy predictions were longer when judging the probability to "*live to*" a certain age than when judging the probability to "*die by*" that age. Subjective probability judgments about longevity and verbal protocols both indicated that the "*live to*" frame evoked more positive thoughts than the "*die by*" frame did. For our context of risk judgments, assuming that the quality *safe* has a positive valence and the quality *dangerous* has a negative valence (Hedger et al., 2016), then according to the valence account of framing, a risk judgment phrased as *How safe is it?* should evoke positive associations that may result in higher judged safety than a risk judgment phrased as *How dangerous is it?* However, other empirical findings cast doubt on whether valence consistent associations adequately account for question framing effects. Although Comerford and Robinson (2017) replicated the results of Payne et al (2013), they also found that the response format influenced the direction of the question framing effect and, we can assume, the underlying cognitive processes. When decision makers reported life expectancy as a point estimate in response to a framed statement "*I expect to live to/die by age…*", life expectancy was longer under the "*die by*" frame. These surprisingly contradictory results highlight the continuing uncertainty about the cognitive processes activated by attribute framing of questions and the direction of the evoked effect.

Communicative accounts of framing effects

Another influential account of framing holds that the pragmatics of language and communication contribute to framing effects (Hilton, 2011; McKenzie, 2004; McKenzie & Nelson, 2003; Sher & McKenzie, 2006). A frame is typically selected by a source (i.e., a speaker) communicating information about the target(s) of judgment. Importantly, the speaker's choice of frame and the listener's inferences about that choice are not arbitrary. Consequently, the choice of frame "leaks" implicit information about a target beyond what is explicitly stated. In this way, logically equivalent frames might not be informationally equivalent because the choice of frame conveys judgment-relevant information, notably the communicator's perspective on the target of judgment. Differently framed questions in survey research are typically also understood according to such a communicative theoretical framework that regards the interaction between researcher and survey respondent as a form of communication subject to the rules of everyday conversation (Grice, 1975). In our study, the differently framed question that elicits the risk judgment could be interpreted as leaking different information about the communicator's (i.e., the researcher's) perception of the target of judgment. When asked the question "*How safe is it?*" the decision maker may plausibly assume that the communicator asking the question perceives the target of judgment to be safe. Otherwise, the communicator would have asked "*How dangerous is it?*" if the target was perceived to be dangerous. Although the cognitive process believed to underlie this framing effect differs from the valence account, the communication account of framing might similarly predict that the term *safe* in the question would elicit judgments of higher safety than would the term *dangerous* in the question.

Attentional accounts of framing

A final account of framing highlights attentional processes. These assert that a frame cues the cognitive system to direct attentional resources toward a certain perspective on the target(s) of judgment while suppressing attention toward alternative perspectives (e.g., Keren, 2011; Teigen, 2015). Judging a target involves cognitive processes that operate in relative terms. All judgments are relative to a reference that is the focus of attention, and the nature and location of that reference influence the judgment (Keren, 2011). Research in psychology using numerically framed single-bound probability judgments found that a frame defines a descriptive state (e.g., more than 85%) as the provisional reference point for the judgment (Hohle & Teigen, 2018; Teigen et al., 2007). The phrasing of the judgment task directs the decision maker's attention toward evaluating whether the target of judgment meets or fulfills that descriptive state, and the decision maker samples different information according to the perspective or reference defined by the frame. For example, a weather forecast predicting that the chance of rain is "greater than 60%" guides attention toward the occurrence whereas a forecast of "less than 70%" guides attention toward the non-occurrence of rain. In that way, a decision maker's judgment in response to a frame is analogous with selectively testing a focal hypothesis defined by that frame (Teigen, 2015). Research in political science on emphasis framing similarly asserts that framing focuses attention on a certain perspective or issue, and consequently that focal issue will have greater weight during the judgment process because of its increased accessibility and applicability (Block & Keller, 1995; Chong & Druckman, 2007; Scheufele & Tewksbury, 2007).

From the perspective of the attention account of framing, we might expect the use of the term *safe* in the question to focus the decision maker's attention on sampling evidence to test the hypothesis that the scenario is indeed safe. Yet when uncertainty is high and definitive evidence is lacking, the decision maker might be expected to conclude that the scenario is not safe because of the insufficiency of evidence in support of that hypothesis. The term dangerous in the question would similarly focus the decision maker's attention on searching for evidence of danger. When no definitive evidence of danger is found, the decision maker would conclude that the scenario is not dangerous because of the insufficiency of evidence in support of that hypothesis. According to the attention account of framing, one would expect judging how safe a situation is to elicit more cautious, more conservative judgments (i.e., *lower* judged safety ratings) than judging how dangerous a situation is under conditions of uncertainty. Conversely, one would expect judging how dangerous a situation is to elicit less cautious, less conservative judgments (i.e., *lower* danger rating or, conversely, *higher* judged safety ratings) than judging how safe a situation is. Importantly, however, it is unclear whether uncertainty is a necessary condition for the cognitive process described by the attention account to produce a framing effect. One could reasonably assume that there would be no question framing effect when encountering sufficient evidence to establish objective safety under the safe frame, or when encountering sufficient evidence to establish objective danger under the danger frame. Although the question frame likely directs evidence sampling under all conditions of (un)certainty, this might only result in a framing effect under conditions of objective uncertainty.

Summary and Research Hypotheses

Three influential accounts of framing make opposing predictions about how the question frames we tested might affect the perceived risk of scenarios of backcountry skiing in avalanche terrain. It is important to note, however, that none of these accounts were developed in the context of qualitatively framing the question that elicits a judgment. Nevertheless, all of these accounts have been used to explain different types of question frames, as reviewed above. Our study differs from previous research investigating these accounts of framing in that we presented participants with highly uncertain visual scenarios in addition to verbal question frames. Although both the valence account and the communication account of framing might predict that judging how safe a situation is would initially elicit higher judged safety, neither account makes strong predictions about how participants subsequently search for information. It is also possible that several or all of the cognitive processes proposed by the different accounts of framing are activated simultaneously or sequentially upon encountering the question frame, in which case we might expect a mixture of effects or no overall effect of framing whatsoever. We test the effect of question framing under conditions of objective uncertainty, safety, and danger in order to ascertain the direction(s) of the effect(s), and thereby infer the cognitive processes activated by a risk judgment framed in terms of safety or danger.

Based on our review of the abovementioned accounts of framing, we predicted in Studies 1 to 4 that the framing of the question that elicited the risk judgment would influence the judged safety of the scenarios, all of which were of uncertain risk. In line with previous work on valence-consistent question framing (e.g., Payne et al., 2013), in Studies 1 and 2 we predicted that a risk judgment phrased as "*How safe is it?*" would elicit higher judged safety than a risk judgment phrased as "*How dangerous is it?*" When the results of Studies 1 and 2 did not confirm this valence-consistent hypothesis, we updated the direction of the predicted effect in Studies 3 and 4 according to the attention account of framing (see, e.g., Keren, 2011). We predicted that the question "*How safe is it?*" would elicit lower judged safety than the question "*How dangerous is it?*" In Studies 5 and 6, we investigated whether the direction of the question framing effect is consistent when judging scenarios of different objective risk levels. We tested two competing hypotheses: 1) the experimental condition would have the same effect on the judged safety of all scenario categories, versus 2) the experimental condition would only influence the judged safety of scenarios of uncertain risk and there would be negligible effects for objectively safe and dangerous scenarios. Finally, we also predicted for all six studies that the variable judged safety would predict behavior intention. In what follows, we report the methods of data collection and analysis that were common for all six studies, and specify any aspects that were unique to any study. We then report the results of each of the six studies.

Methods of Data Collection and Analysis for Studies 1 to 6

Across six studies (N = 1599), we tested how risk perceptions and decisions are influenced by the qualitative frame of the question that elicits the risk judgment (i.e., the question frame). Using a series of hypothetical scenarios involving backcountry skiing in avalanche terrain, participants judged either *how safe* or *how dangerous* each scenario was and indicated whether they would ski the scenario. We confirm that at the time of writing, the six studies reported in this article are all the studies we conducted on the effect of question framing on risk judgments and decisions. We report all measurements assessed and all manipulations implemented in each study. The studies were approved by the Department of Psychology Research Ethics Committee, UiT The Arctic University of Norway. All studies except Study 4 were pre-registered. The pre-registrations, data, R script for data processing and analysis, and the scenarios used in the studies are available on the Open Science Framework (https://osf.io/sknxf/).

Participants. Table 1 presents the sample size and information about the sample for each of the six studies. Due to a technical failure, we were unable to collect data on participant age, gender, or experience measures in Study 1. Each of the six studies was conducted during a public seminar on safety and decision-making for backcountry skiers in avalanche terrain, with the seminar audience members as participants. Each seminar was at a different location in Norway during the winter of 2019 to 2020. The audience members at the six seminars were recreational backcountry skiers with varying degrees of experience judging avalanche risk during ski tours in avalanche terrain. Consequently, there was a self-selection for experienced participants in all six studies. Table 2 presents descriptive statistics on participants' experience with the judgment tasks and the activity presented in the scenarios. The seminar in which we conducted Study 1 had a nominal entry fee of NOK 50 (approximately 6 USD) whereas the other five seminars were free to attend. Participation was voluntary and all participants indicated their informed consent to participate. All six studies were conducted in Norwegian.

We did not conduct a priori power analysis to determine target sample size for any study. The audience size at a seminar determined the possible number of participants in the study conducted at that event. We recruited as many participants as possible during each seminar and did not continue data collection for the respective study beyond that seminar, but otherwise had no control over the final sample size of each study. We set a minimum sample size for each study of approximately 60% of the anticipated audience size for that seminar. Participation exceeded 60% of the actual audience size for all six studies and we met the estimated minimum number of participants for Studies 1 to 5. Although more than 60% of the audience participated in Study 6, we overestimated the expected audience size and did not meet the minimum number of expected participants.

Table 1

Participants in Studies 1 to 6, including sample sizes, division of participants by experimental condition, and data on participants' gender and age. Gender self-identification categories are male (M), female (F), other (O), withheld (W), and data not available (NA). Gender and age data are unavailable for Study 1.

Study	*N*	Experimental condition		Gender self-identification					*M* age	*SD* age	Range age
		Safe	Danger	M	F	O	W	NA			
1	735	351	384	-	-	-	-	735	-	-	-
2	197	102	95	131	53	2	1	10	37	10.95	18-62
3	255	132	122	156	99	0	0	0	38	11.40	18-65
4	173	86	87	90	81	2	0	0	37	11.79	18-73
5	168	66	102	94	74	0	0	0	32	10.17	18-67
6	71	32	39	35	34	2	0	0	29	8.91	19-53

Table 2

Participant experience with the judgment tasks for Studies 1 to 6, including average number of years skiing in avalanche terrain (M_{Years}, response scale from 0 to 40 years), average number of days in avalanche terrain per season (M_{Days}, response scale from 0 to 100 days), and median level of self-reported avalanche safety training ($M_{Training}$, reported on 7-point scale with "1 – None" and "7 – Expert level qualifications" at the scale ends).

Study	*N*	M_{Years}	M_{Days}	$M_{Training}$
1	735	-	-	-
2	197	8.51	12.02	3
3	255	11.77	14.38	2
4	173	9.54	15.03	2
5	168	7.87	8.36	3
6	71	8.10	28.17	3

Design. All six studies used the same experimental design, measures, and procedures described here. We used a between-subject design with two experimental conditions—the Safe Group or the Danger Group—for the qualitative attribute that framed the risk judgments. All judgment tasks were programmed in Qualtrics. One seminar leader conducted Studies 1, 2 and 6, another seminar leader conducted Studies 3 and 5, and a third seminar leader conducted Study 4. Each seminar began with a presentation of the information resources that are publicly available online from the Norwegian Avalanche Warning Service. After that, the seminar leader announced the study explaining that researchers were investigating information use for avalanche risk judgments. The seminar leader then projected the link to the online study for participants to access via their internet connected mobile devices. Upon accessing the study, participants were randomly assigned by the software to one of the two experimental conditions after indicating their informed consent to participate.

Materials. Participants judged a series of hypothetical scenarios of backcountry skiing in avalanche terrain. Each scenario consisted of a photograph of a person skiing a snow-covered slope (one scenario photo included three people). We hold the rights of use for all photos. In the upper right corner of each photograph were icons indicating the slope angle, the prevailing regional avalanche problem(s), and the forecasted regional avalanche danger level (5-point scale) for that scenario. The icons used are standardized icons defined by the European Avalanche Warning Services (EAWS) and used by the Norwegian Avalanche Warning Service in daily regional avalanche danger forecasts throughout the country. These icons provide valuable objective information for judging the degree of risk.

We developed three categories of scenarios: scenarios of uncertain risk, safe scenarios, and dangerous scenarios, as defined by avalanche experts. An avalanche expert selected photographs from a personal library and assigned icons to those photographs to create scenarios of differing risk level. The combination of visual evidence in the photograph and the information conveyed by the icons established the objective risk level of each scenario. Uncertain scenarios lacked definitive evidence of safety or danger because the available evidence in the photo and the icons were ambiguous and/or conflicting. For example, although the icons on the steepness of the slope and the prevailing avalanche problems together indicate an increased probability of an avalanche, the icon indicating a danger level of two (on a five-point scale) and the terrain features depicted in the photograph indicate a reduced probability of avalanche. The risk level of that scenario would be objectively uncertain given the conflicting evidence. By contrast, the photographs and icons in the safe and dangerous scenarios conveyed sufficient evidence to ascertain the objective safety or danger of the scenario. For example, although an icon indicates the prevailing regional avalanche problem, no signs indicative of the presence of that problem are evident in the photograph. Additional icons in that scenario indicate a low regional danger forecast and a low slope angle. That scenario is objectively safe because all the evidence align to indicate that an avalanche is extremely unlikely. The objective uncertainty of the uncertain scenarios, the objective safety of the safe scenarios, and objective danger of the dangerous scenarios were established by the avalanche expert who designed the scenarios, and independently confirmed by a second avalanche expert. All scenarios used in the six studies are available on the Open Science Framework at https://osf.io/sknxf/.

Participants in Studies 1 to 4 judged six uncertain scenarios. We used the same six uncertain scenarios for all four studies, changing their order of presentation between studies to account for any possible order effect. Participants in Studies 5 and 6 judged ten scenarios: four scenarios of uncertain risk, three safe scenarios, and three dangerous scenarios. We used the same set of ten scenarios for both studies. The four uncertain scenarios used in Studies 5 and 6 were selected from among the six uncertain scenarios previously used in Studies 1 to 4. The three safe scenarios and the three dangerous scenarios used in Studies 5 and 6 were new. We anticipated the possibility of an effect from the order in which the categories of scenarios were judged. We therefore reversed the order of presentation between Studies 5 and 6. In Study 5, we first presented the three dangerous scenarios followed by the four uncertain scenarios, and lastly the three safe scenarios. In Study 6, we first presented the three safe scenarios, then the four uncertain scenarios, and finally the three dangerous scenarios. Although we reversed the order of the scenario categories in Study 6, the order of the scenarios within each category was the same in both studies.

Measures. The scenarios were sequentially projected onto the auditorium screen for all participants in the audience to see. All questions were displayed exclusively in Qualtrics on participants' personal mobile devices. Participants in the Safe Group judged the scenarios by answering the question "*How safe is it?*" responding on a 7-point scale labeled "*Not at all safe*" and "*Completely safe*" at the extreme points. Participants in the Danger Group judged the same scenarios by answering the question "*How dangerous is it?*" responding on a 7-point scale labeled "*Not at all dangerous*" and "*Completely dangerous*" at the extreme points. Upon completing each risk judgment, participants in both experimental groups were asked the question "*Would you ski this slope?*" with the three response options "*No*", "*I cannot say*" or "*Yes*". Participants had approximately one minute per scenario to answer the risk judgment and the behavior intention questions before the next scenario was projected. Participants were instructed not to discuss with their neighbors during the study and the seminar leaders confirmed that all auditoriums were silent during data collection. Participants were not required to answer the questions to proceed to the next scenario. Upon completing the scenarios, participants answered questions about their age, gender, and nationality. Finally, participants reported their skiing ability, avalanche training, years of backcountry skiing experience, average number of backcountry skiing days per season, and past exposure to avalanche incidents. However, due to a technical failure, these covariates were not measured at all locations and are therefore not considered in our analysis.

Data preparation and analysis: We used R (R Core Team, 2017) for all data preparation and analyses. We reverse coded the risk judgment scores of participants in the Danger Group to make them comparable to the risk judgments of participants in the Safe Group. We henceforth refer to the judged risk as *judged safety* for both experimental conditions. There were missing values of judged safety (Study 1 = 2.3%; Study 2 = 5.1%; Study 3 = 1.0%; Study 4 = .5%; Study 5 = .1%; Study 6 = .6%) and behavior intention (Study 1 = 2.4%; Study 2 = 4.6%; Study 3 = 1.2%; Study 4 = .4%; Study 5 = .1%; Study 6 = 0%) within the data. We deemed those values to be missing at random. Mixed model analyses can handle missing values without requiring the exclusion of participants for whom only partial data was collected (Baayen et al., 2008). We therefore did not impute any data for missing values. For Studies 5 and 6, we subset the data by scenario category. We treated judged safety and behavior intention as ordinal variables. To examine whether the experimental condition influenced the odds of each value of judged safety, we used the *ordinal* package (Christensen, 2019) to implement cumulative link mixed models via Laplace approximations for the hypothesized model with judged safety as the outcome variable and the experimental condition as the predictor variable. We included intercepts for participants and scenarios as random effects to account for by-subject and by-scenario variability. We calculated Chi-square values (χ^2) with likelihood-ratio tests comparing the model that included the predictor variable(s) under investigation as the fixed effect (and participants and scenarios as random effects) against an equivalent model that excluded that predictor variable(s). To examine predictors of behavior, we estimated ordinal mixed models via Laplace approximations to analyze whether the predictor variables experimental condition, judged safety or their interaction predicted the odds of the outcome variable self-reported behavior intention. We defined the response order of behavior intention as "*No*" < "*I cannot say*" < "*Yes*". We treated the predictor judged safety as an interval variable for all analyses involving behavior intention as the outcome variable. We included intercepts for participants and scenarios as random effects, thereby accounting for by-subject and by-scenario variability. We calculated Chi-square values (χ^2) with likelihood-ratio tests using the method described above.

Results

Studies 1 to 4: Single Reference Judgments of Uncertain Scenarios

Table 3 presents the proportions of judged safety values per experimental condition for Studies 1 to 4, with mode values clearly marked. The experimental condition influenced judged safety in all studies: Study 1, $\chi^2(1) = 30.49$, $p < .001$; Study 2, $\chi^2(1) = 12.25$, $p < .001$; Study 3, $\chi^2(1) = 19.65$, $p < .001$; and Study 4, $\chi^2(1) = 8.14$, $p = .004$. The log-odds coefficients and odds ratios for the main effect experimental condition for each study are presented in Table 4. Participants in the Danger Group who judged "*How dangerous is it?*" were at least 1.6 times more likely to judge a scenario to be safer than participants in the Safe Group who judged "*How safe is it?*". The probabilities of each value of judged safety per experimental condition are presented in Figure 1. In all four studies, judged safety was higher when judged in terms of how dangerous the scenario was than when judged in terms of how safe the scenario was.

Table 3 presents the proportions of behavior intention values per experimental condition for Studies 1 to 4, with mode response clearly marked. Judged safety predicted behavior intention in all four studies: Study 1, $\chi^2(1) = 1995.60$, $p < .001$, Study 2, $\chi^2(1) = 451.93$, $p < .001$, Study 3, $\chi^2(1) = 609.66$, $p < .001$, and Study 4, $\chi^2(1) = 388.44$, $p < .001$. The experimental condition alone, as a main effect, marginally predicted behavior in Study 2, $b = -.37$, $SE = .20$, $\chi^2(1) = 3.56$, $p = .059$, although that effect is mediated by the main effect judged safety (see Table 5). Otherwise, the experimental condition alone did not predict behavior in Studies 1, 3 or 4. The addition of the main effect experimental condition to the model with the main effect judged safety predicted behavior intention in Study 1, $\chi^2(1) = 17.76$, $p < .001$, and Study 3, $\chi^2(1) = 11.51$, $p < .001$, and marginally predicted behavior in Study 4, $\chi^2(1) = 2.69$, $p = .101$. The log-odds coefficients and odds ratios for the influence of the main effects judged safety and experimental condition on behavior intentions are presented in Table 5. Figure 2 illustrates the probability of each behavior per judged safety value per experimental condition. An interaction between the experimental condition and judged safety did not predict behavior intention in any of the four studies: Study 1, $\chi^2(1) = 1.56$, $p = .211$, Study 2, $\chi^2(1) = 1.05$, $p = .305$, Study 3, $\chi^2(1) = .02$, $p = .896$, or Study 4, $\chi^2(1) = .00$, $p = .949$. Overall we found that as the value of judged safety increased, the probability that participants in both experimental groups would ski the slope in the scenario increased. If participants in both experimental conditions judged safety to be equal, the probability that participants in the Safe Group would ski a slope was higher than that of participants in the Danger Group. However, based on the magnitude of the log-odds coefficients and the odds ratios, judged safety had the greatest predictive power of behavior intention. Consequently, participants in the Safe Group were qualitatively less inclined to indicate that they would ski a slope because they were more likely to judge safety as lower.

To further investigate the robustness and scope of these measured effects, we conducted two additional studies using a broader set of scenarios with different levels of objective risk. Participants in Studies 1 to 4 judged scenarios that were all of uncertain risk. Is it possible that the high degree of uncertainty in some way influenced or accounted for the observed effect? Is uncertainty a prerequisite for the effect or does the question framing effect extend to situations that are objectively safe or dangerous? These are important questions because in a real world context, people encounter a range of situations of different objective risk with varying degrees of uncertainty. Understanding the contexts to which the observed question framing effect extends will inform strategies for its potential application. We therefore conducted Studies 5 and 6 using scenarios in three categories of objective risk—uncertain scenarios, safe scenarios, and dangerous scenarios—to examine if the effect observed in Studies 1 to 4 is present under varying degrees of objective risk and uncertainty.

Table 3

Percentage of judged safety values (values 1 to 7) and percentage of behavior (No = No, I would not ski the slope, UD = Undecided, I cannot say, and Yes = Yes, I would ski the slope) per experimental condition for Studies 1-4. The mode judged safety value and the mode behavior per experimental condition is marked by bold font.

Frame	Judged safety score							Behavior		
	1	2	3	4	5	6	7	No	UD	Yes
Study 1										
Safe	17.7	21.2	**22.0**	17.4	14.2	5.7	1.8	**49.7**	7.9	42.4
Danger	12.7	15.5	**23.1**	22.5	17.9	7.3	1.0	**49.9**	5.5	44.6
Study 2										
Safe	24.0	**27.0**	20.6	13.5	9.9	4.1	.9	**56.6**	8.9	34.5
Danger	18.9	17.5	**22.0**	21.0	14.1	6.1	.4	**52.2**	4.2	43.6
Study 3										
Safe	**22.9**	19.8	21.6	20.1	12.0	2.4	1.2	**47.1**	6.1	46.8
Danger	11.8	17.0	24.0	**25.3**	17.5	3.7	.7	45.9	7.7	**46.4**
Study 4										
Safe	25.2	**26.6**	24.1	16.1	5.6	2.0	.4	**61.8**	6.6	31.6
Danger	18.5	23.0	**23.4**	19.7	12.7	2.5	.2	**60.8**	3.5	35.7

Table 4

Coefficients of the model (judged safety ~ experimental condition) predicting whether the experimental condition influences judged safety for Studies 1-4

	$b_{Danger\ frame}$ (*SE*)	*95% CI* for Odds Ratios (OR)			*p*-value
		Lower	OR	Upper	
Study 1	.47 (.08)	1.36	1.60	1.89	< .001
Study 2	.63 (.18)	1.33	1.89	2.68	< .001
Study 3	.72 (.16)	1.50	2.04	2.79	< .001
Study 4	.60 (.21)	1.21	1.81	2.72	.004

Figure 1

Probabilities of judged safety values by experimental condition, with 95% confidence intervals, for Studies 1-4.

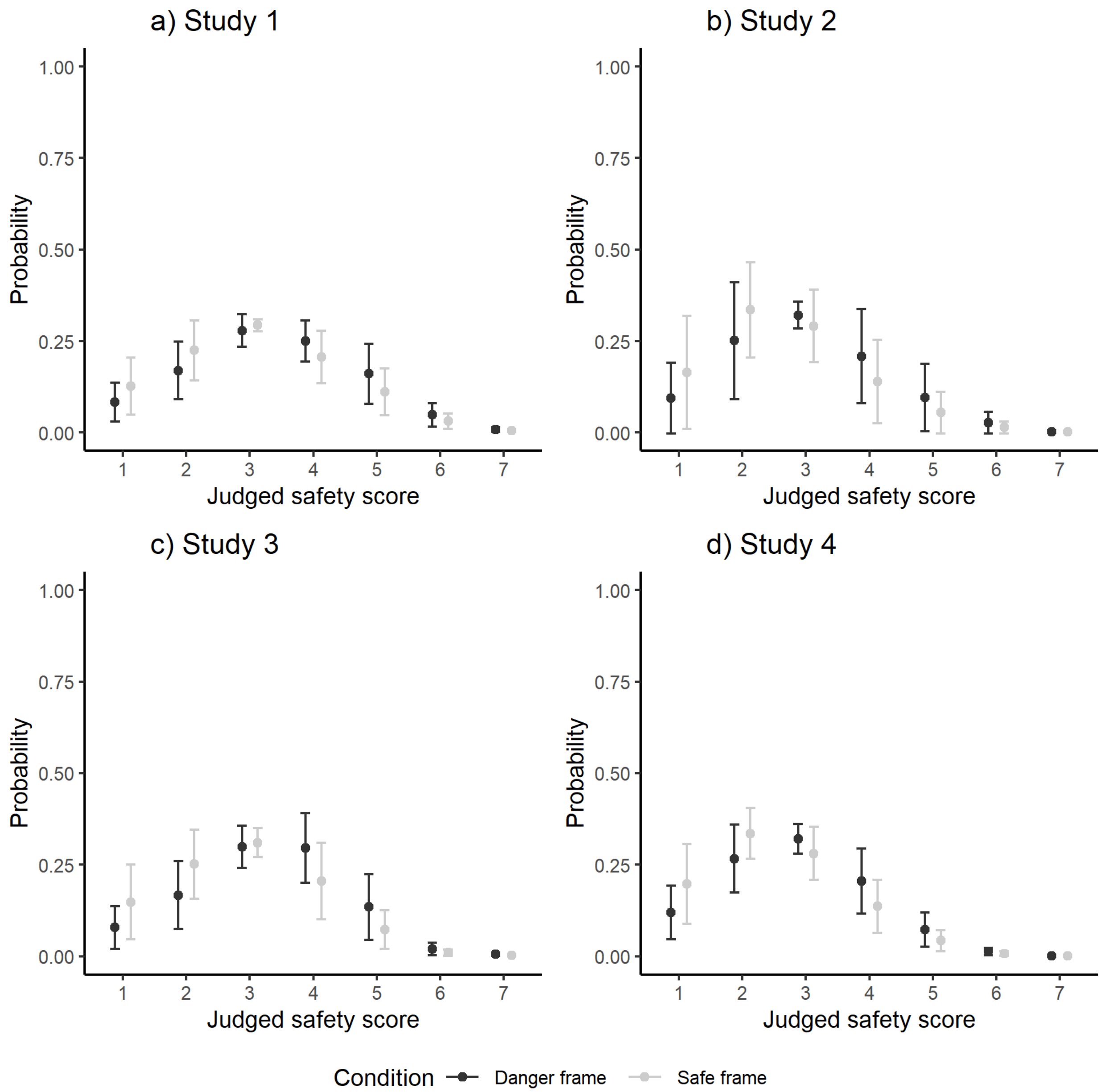


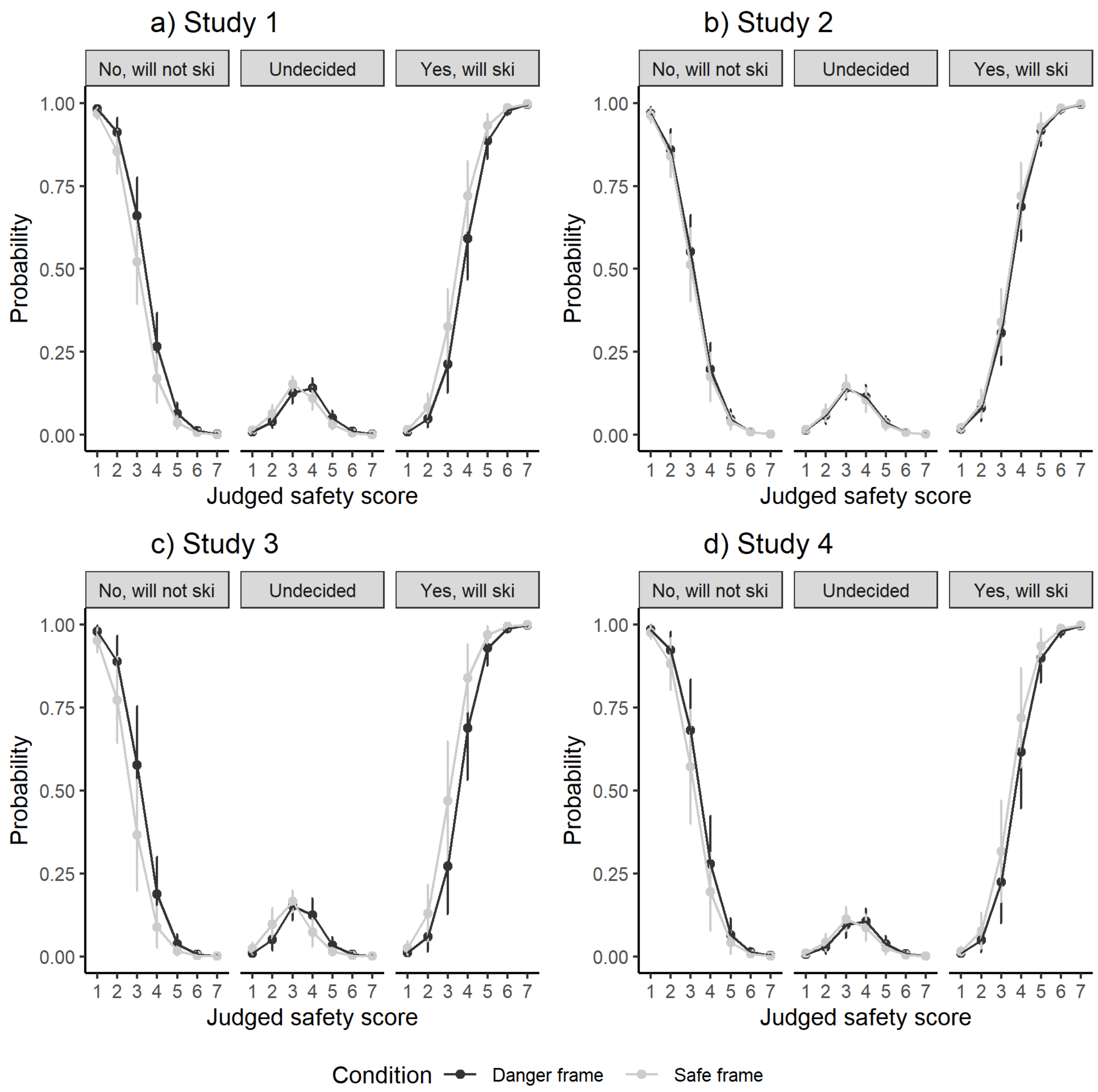
Table 5

Coefficients of the model (behavior ~ judged safety + experimental condition) predicting whether the terms judged safety and experimental condition influences behavior intention in Studies 1-4

	b (*SE*)	*95% CI* for Odds Ratios (OR)			*p*-value
		Lower	OR	Upper	
Study 1					
Judged safety	1.67 (.06)	4.76	5.34	5.98	< .001
Safe frame	.57 (.14)	1.36	1.78	2.32	< .001
Study 2					
Judged safety	1.60 (.11)	3.98	4.98	6.23	< .001
Safe frame	.15 (.26)	.69	1.17	1.96	.562
Study 3					
Judged safety	1.77 (.11)	4.78	5.90	7.29	< .001
Safe frame	.86 (.25)	1.43	2.36	3.88	< .001
Study 4					
Judged safety	1.71 (.13)	4.30	5.54	7.13	< .001
Safe frame	.47 (.29)	.91	1.60	2.80	.101

Figure 2

Probabilities, with 95% confidence intervals, of skiing the scenario slope by judged safety values and experimental condition for Studies 1-4.



Studies 5 and 6: Single Reference Judgments of Uncertain, Safe and Dangerous Scenarios

Table 6 presents the proportions of judged safety values per experimental condition for each category of scenarios in Studies 5 and 6, with the mode values clearly marked. In Study 5, the experimental condition influenced judged safety—presented according to the order in which participants judged the categories of scenarios—for dangerous scenarios, $\chi^2(1) = 52.59$, $p < .001$, and scenarios of uncertain risk, $\chi^2(1) = 10.28$, $p = .001$, but did not influence the judged safety for safe scenarios, $\chi^2(1) = .55$, $p = .457$, which participants judged last. In Study 6, the experimental condition influenced judged safety—presented according to the order in which participants judged the categories of scenarios—of safe scenarios, $\chi^2(1) = 12.45$, $p < .001$, did not influence the judged safety of scenarios of uncertain safety, $\chi^2(1) = 2.29$, $p = .130$, and influenced the judged safety of dangerous scenarios, $\chi^2(1) = 85.37$, $p < .001$. The log-odds coefficients and odds ratios for the main effect experimental condition per scenario category are presented in Table 7. The probabilities of each value of judged safety per scenario category by experimental condition are presented in Figure 3. Apart from the safe scenarios that were judged last in Study 5 and the uncertain scenarios that were judged second in Study 6 for which there was no effect, participants in the Danger Group were more likely to judge all categories of scenarios to be safer than participants in the Safe Group. Study 5 and Study 6 replicated the result that framing the risk judgment in terms of safety was more likely to result in lower judged safety whereas framing the risk judgment in terms of danger was more likely to result in higher judged safety.

Table 6 presents the proportions of behavior intention values per experimental condition for Studies 5 and 6, with the mode response clearly marked. The main effect judged safety predicted behavior intention for safe scenarios in Study 5, $\chi^2(1) = 112.21$, $p < .001$, and Study 6, $\chi^2(1) = 113.67$, $p < .001$; for uncertain scenarios in Study 5, $\chi^2(1) = 322.23$, $p < .001$, and Study 6,

$\chi^2(1) = 133.74$, $p < .001$; and for dangerous scenarios in Study 5, $\chi^2(1) = 28.32$, $p < .001$, and Study 6, $\chi^2(1) = 3.14$, $p < .076$. The experimental condition alone, as a main effect, predicted behavior for safe scenarios in Study 6, $\chi^2(1) = 8.47$, $p < .003$; an effect that is mediated by the main effect judged safety (see Table 8). Otherwise, the experimental condition alone did not predict behavior intention in either Study 5 or Study 6. The addition of the main effect experimental condition to the model with the main effect judged safety predicted behavior intention for uncertain scenarios in Study 5, $\chi^2(2) = 6.41$, $p = .011$, and an interaction between judged safety and the experimental condition predicted behavior for the safe scenarios in Study 5, $\chi^2(1) = 6.78$, $p = .009$. However, the experimental condition had no influence on behavior for the safe scenarios or the uncertain scenarios in Study 6 beyond what was predicted by judged safety. The log-odds coefficients and odds ratios for the influence of the main effect judged safety together with the main effect experimental condition (and their interaction, if relevant) on behavior intentions are presented in Table 8. As the value of judged safety increased, the probability that participants in both experimental groups would ski the slope increased for safe scenarios and scenarios of uncertain risk. Studies 5 and 6 replicated the result that judged safety had the greatest predictive power of behavior intention. Participants in the Safe Group were therefore qualitatively less inclined to indicate that they would ski a slope because they were more likely to judge safety as lower. As for dangerous scenarios, there were too few measures of judged safety values greater than 4 in Study 5 and greater than 3 in Study 6 to reliably test for an interaction effect between judged safety and experimental condition. This is indicated by the range of the 95% CI in Figure 4. Participants in both experimental groups in Studies 5 and 6 were effectively unanimous that it was 100% likely that they would not ski the slopes in the dangerous scenarios.

Table 6

Percentage of judged safety values (values 1 to 7) and percentage of behavior (No = No, I would not ski the slope, UD = Undecided, I cannot say, and Yes = Yes, I would ski the slope) per experimental condition (column Group) and per scenario category (column Scenario, S = safe, UR = uncertain risk, and AD = dangerous) for Studies 5 and 6. The mode judged safety value and the mode behavior per experimental condition and per scenario category is marked by bold font.

Frame	Scenario	Judged safety score							Behavior		
		1	2	3	4	5	6	7	No	UD	Yes
Study 5											
Safe	Safe	1.0	3.1	6.6	11.7	22.3	**34.5**	20.8	8.6	2.0	**89.4**
Danger	Safe	.0	1.0	6.8	10.8	23.9	**37.9**	19.6	5.6	2.9	**91.5**
Safe	Uncertain	11.7	27.6	**29.6**	19.7	9.8	.8	.8	**59.1**	9.1	31.8
Danger	Uncertain	8.6	15.9	26.5	**30.4**	14.7	3.4	.5	**57.1**	7.6	35.3
Safe	Dangerous	**66.2**	25.8	6.0	2.0	.0	.0	.0	**96.0**	2.5	1.5
Danger	Dangerous	**37.2**	24.5	15.7	13.4	6.9	1.6	.7	**95.1**	.3	4.6
Study 6											
Safe	Safe	3.2	7.4	14.9	18.1	**28.7**	14.9	12.8	16.7	13.5	**69.8**
Danger	Safe	.8	2.6	6.8	9.4	29.1	**29.9**	21.4	10.2	2.6	**87.2**
Safe	Uncertain	26.0	**32.3**	23.6	9.4	5.5	2.4	.8	**68.7**	13.3	18.0
Danger	Uncertain	21.9	22.0	**31.6**	14.2	10.3	.0	.0	**69.2**	10.3	20.5
Safe	Dangerous	**92.7**	6.3	1.0	.0	.0	.0	.0	**96.9**	2.1	1.0
Danger	Dangerous	**55.6**	13.7	20.5	6.0	4.3	.0	.0	**97.4**	2.6	.0

Table 7

Coefficients of the model (judged safety ~ experimental condition) predicting whether the experimental condition influences judged safety per scenario category for Studies 5 and 6.

	$b_{Danger\ frame}$ (*SE*)	*95% CI* for Odds Ratios (OR)			*p*-value
		Lower	OR	Upper	
Study 5					
Safe scenarios	.20 (.27)	.72	1.22	2.08	.457
Uncertain scenarios	.88 (.27)	1.42	2.42	4.15	.001
Dangerous scenarios	1.97 (.28)	4.14	7.17	12.42	< .001
Study 6					
Safe scenarios	1.62 (.46)	2.07	5.08	12.45	< .001
Uncertain scenarios	.43 (.28)	.88	1.53	2.66	.130
Dangerous scenarios	3.35 (.64)	8.06	28.42	100.18	< .001

Figure 3

Probabilities of judged safety values per experimental condition and per scenario category, with 95% confidence intervals, for Studies 5 and 6.

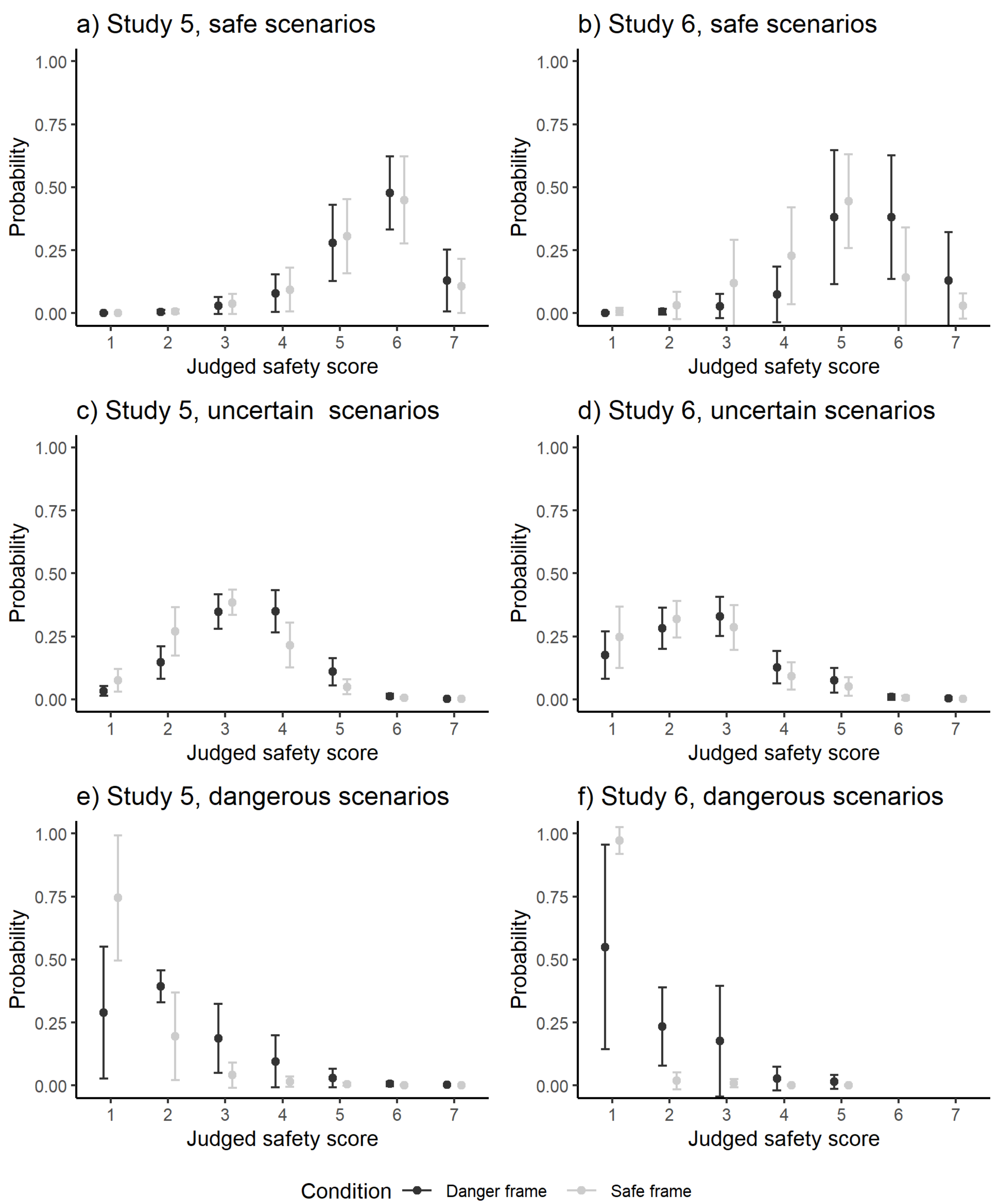


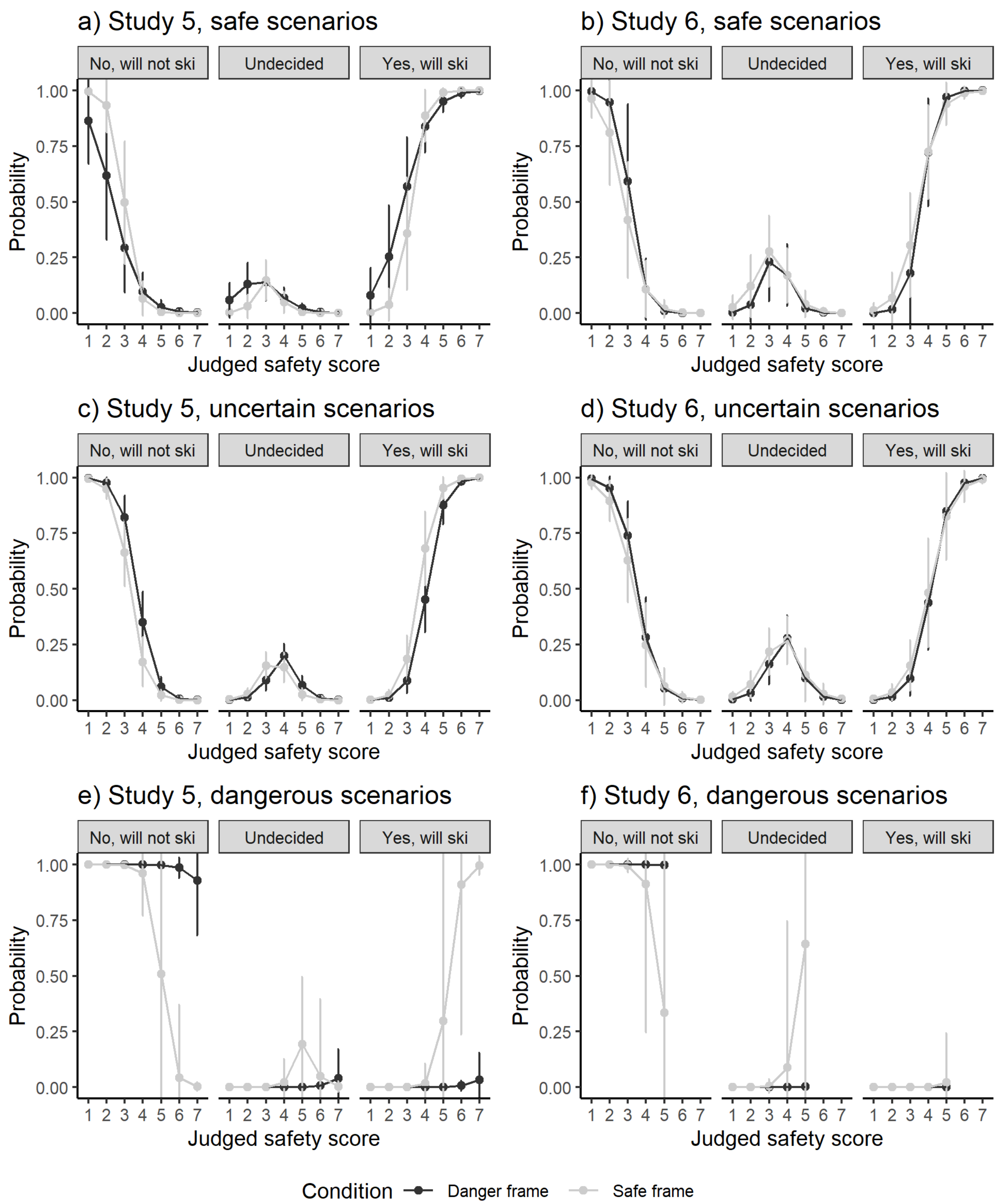
Table 8

Coefficients of the model predicting whether the terms judged safety and experimental condition influences behavior intention per scenario category in Studies 5 and 6

	b (*SE*)	Odds Ratios (OR) 95% CI			*p-value*
		Lower	OR	Upper	
Study 5, safe scenarios					
Judged safety	1.36 (.28)	2.25	3.90	6.75	< .001
Safe frame	-4.71 (2.23)	.00	.00	.71	.034
Judged safety * safe frame	1.28 (.59)	1.14	3.60	11.39	.029
Study 5, uncertain scenarios					
Judged safety	2.18 (.19)	6.11	8.88	12.91	< .001
Safe frame	.89 (.35)	1.22	2.44	4.88	.012
Study 6, safe scenarios					
Judged safety	2.02 (.46)	3.09	7.56	18.46	< .001
Safe frame	.11 (.55)	.37	1.11	3.33	.849
Study 6, uncertain scenarios					
Judged safety	1.79 (.25)	3.68	6.00	9.78	< .001
Safe frame	.50 (.47)	.65	1.65	4.19	.288

Figure 4

Probabilities, with 95% confidence intervals, of skiing the scenario slope by judged safety values per experimental condition per scenario category for Studies 5 and 6.



General Discussion

Results from six studies demonstrate that risk perception is influenced by the frame of the question that elicits the risk judgment. Framing a risk judgment in terms of safety ("*How safe is it?*") was more likely to result in lower judged safety than framing that risk judgment in terms of danger ("*How dangerous is it?*"). The results of Studies 5 and 6 indicate that uncertainty is not a prerequisite for this framing effect. The question frame had a consistent direction of effect when judging safe scenarios, uncertain scenarios, and dangerous scenarios, suggesting that, in principle, the effect from framing risk judgments in terms of safety or danger applies in all situations of objective risk.

Question Frames Guide Attention during Information Sampling

A question frame elicits a judgment that is relative to the reference defined by the frame. This process can be thought of as analogous to testing the hypothesis defined by the frame. The question "*How safe is it?*" defines *safe* as the provisional reference point for the risk judgment, whereas the question "*How dangerous is it?*" defines dangerous as the provisional reference point for the risk judgment. This has the effect of focusing the decision maker's attention on selectively sampling evidence to evaluate whether the target of judgment meets or fulfills the descriptive state defined by the question frame rather than judging the degree of risk according to the two complementary poles *completely safe* and *completely dangerous*. Participants presented the safe frame judged whether the available evidence was sufficient to establish whether a scenario was indeed safe. Participants presented the danger frame judged the available evidence with a focus on ascertaining whether the same scenario was indeed dangerous. To ask how safe a scenario is or to ask how dangerous it is are therefore not informationally equivalent frames, despite being complementary dimensions of the bipolar attribute *risk*. Each question focuses the decision maker's attention on selectively sampling different evidence in relation to different reference points (Chong & Druckman, 2007; Druckman, 2001; Keren, 2011; Teigen, 2015), effectively making each question a different judgment task. This is particularly relevant in a decision environment such as avalanche terrain where information cues rarely have logically equivalent opposites. There is an asymmetry of relevant evidence between the frames. Although the presence of one sign indicates increased danger and the greater probability of an avalanche, that sign may have no logically equivalent opposite. Moreover, the absence of that sign is not necessarily an indication of increased safety.

Participants in our studies sampled different evidence in relation to the reference point defined by the question frame and reported their judgment on a scale similarly defined by that reference point. As illustrated in Figure 5, participants searched for evidence of safety if *safe* framed the question eliciting the risk judgment, or searched for evidence of danger if *danger* framed the question. Yet under conditions of high uncertainty, there was insufficient evidence to definitively establish or reject the descriptive state that either reference point emphasized. The evidence in favor of either reference point was ambiguous and therefore participants judging safety concluded that a scenario was not definitively safe, whereas participants judging danger similarly concluded that the same scenario was not entirely dangerous. Under both frames, participants adjusted their reported judgment according to the perceived (in)sufficiency of evidence for their respective reference point defined by the question frame. Those adjustments were made in relation to the limits, also defined by the question frame, of their respective reporting scales. However, the available evidence and consequently the adjustment on the response scale differed between the framing conditions. As a result, participants who were presented the safe frame judged the scenarios to be relatively more dangerous (alternatively, relatively less safe), while participants who were presented the danger frame judged the same scenarios to be relatively safer (alternatively, relatively less dangerous).

Interestingly, we observed this effect when participants judged dangerous and safe scenarios. Despite the availability of what avalanche experts consider to be definitive evidence of the objective safety and danger of the scenarios, participants who faced the safe frame did not accept the reference point *safe* for safe scenarios, and consequently judged them to be relatively less safe than participants who faced the danger frame did. Similarly, when judging dangerous scenarios, those who faced the danger frame did not accept the reference *danger* defined by that frame, and consequently judged dangerous scenarios to be relatively less dangerous (i.e., more safe) than participants under the safe frame. Objective uncertainty was not a requirement for the question frame to evoke selective evidence sampling relative to the reference point defined by the frame. Although a framing effect was not measured for judgments of safe scenarios in Study 5 and uncertain scenarios in Study 6, we suspect this to be the result of the order in which participants judged the scenarios. When judging scenarios of different objective risk levels, participants might have judged a given scenario in relation to the sufficiency of evidence and the judged safety/danger of the previous scenario(s). We also suspect that an order effect was the cause of the different magnitude of measured effects between scenarios categories in Studies 5 and 6. Examining the role of presentation order more directly may be an interesting direction for future work, but a challenge would be to ensure that such an investigation is ecologically valid. It is unlikely that a person would judge vastly different conditions in close temporal proximity. Thus the order effects we observed here may have been, to some extent, an artifact of overly stark contrasts between objective risk levels.

The Possibility of Other Cognitive Processes during Question Frames

The direction of the question framing effect we observed across six studies runs counter to what might be expected based on alternative accounts of framing that assume a valence or communication driven mechanism. In particular, both the valence account and the communication account of framing would be consistent with judged safety being higher when judging "How safe is it?" Earlier research found on the direction of the question framing effect and the underlying cognitive processes found conflicting results. Payne and colleagues (2013) found credible evidence of a question framing effect consistent with the valence account of framing. Although Comerford and Robinson (2017) replicated the results of Payne and colleagues when testing the same judgment task, when they replaced the reporting format from a probabilistic estimate to a point estimate, their results indicated a framing effect in the opposite direction.

This apparent mismatch between the predictions of other framing accounts and our findings may be linked to the specific framing paradigm we used. In addition to specifying a verbal question frame (how safe vs. dangerous is it?), the judgment task we used involved sampling information beyond what was described by the question frame. This process of information sampling is not a common element in most judgment tasks used in other research on framing, and the cognitive processes underlying framing effects likely depend on the method by which the frame is achieved. Kreiner and Gamliel (2018), for instance, found evidence that attention mechanisms contribute to attribute framing but recognized that their experimental design prevented them from ruling out the potential contribution of valence mechanisms to the overall framing effect. Similarly, in our paradigm, attentional mechanisms may have played a dominant role because we included an information-sampling component and because the frame was achieved by the phrasing of a question (rather than a statement). Yet we cannot rule out that valence-driven and communicative mechanisms also played a role in the results of our study. Participants' initial prior when prompted with the question *How safe is it?* may well have leaned toward the valence of that frame, but was then revised in the process of gathering insufficient evidence to support this initial hypothesis. Thus, framing may be an aggregation of different forces resulting from distinct cognitive processes that are evoked by the judgment task and the manner in which the frame is achieved. An interesting avenue for future research is to use computational cognitive modeling to disentangle the cognitive processes that drive question framing.

Figure 5

A conceptualization of the decision making processes under each experimental framing condition. The person on the left represents the Safe Group judging risk in response to the question "How safe is it?" The person on the right represents the Danger Group judging risk in response to the question "How dangerous is it?" The thought bubbles illustrate the assumed cognitive process up to the behavior decisions expressed in the speech bubbles. The icons in the top left and the "35°" are examples of the information provided in the scenarios. They represent the forecasted regional avalanche danger rating (3), the avalanche problem, and the slope angle.

The Indirect Influence of Question Framing on Behavior Decisions

Beyond the effect of question framing on judged safety, the results from all six studies indicate that judged safety influenced participants' hypothetical behavior intention. The probability that participants would ski the slope monotonically increased with an increase in judged safety. The only exception to this clear result concerned the judgments of dangerous scenarios, for which participants were effectively unanimous that irrespective of judged safety they would not ski the slope (see Figure 4). However, it is very rare for dangerous slopes to be so clearly marked as dangerous, as they were in our studies, by evidence of an active avalanche on that particular slope. Typical of a wicked learning environment (Hogarth et al., 2015), a dangerous slope commonly resembles an uncertain slope until someone travels on it triggering an avalanche, thus providing clear but rare evidence of the objective risk level, albeit a little too late.

Indecision was a response option for the measure of behavior intention, and a small proportion of responses (ranging from .3 to 13.5% across all studies and scenario categories) indicated that participants were undecided about their intended action. The likelihood of such indecision was highest when scenarios were perceived to be neither completely safe nor completely dangerous, with judged safety values in the middle range of the response scale. This establishes that the judged safety response scale captured the equivalent poles of the bipolar attribute of judgment, despite only one of those poles framing the judgment task. However, it is important to point out that indecision is not a true response option in a real-world situation; either skiing the slope or not skiing the slope are only ever observed.

Behavior is what exposes people to risk. That judged safety influenced behavior intention is particularly important for our examination of question framing and the possibility of harnessing that framing effect to promote safer risk judgments and decisions. Although there was no overall effect of framing on hypothetical behavioral intent, it is important to emphasize the process by which question framing influenced behavior. Question framing was found to influence judged safety, and judged safety was in turn found to be a powerful determinant of behavior decisions. Since behavior is the immediate cause of risk exposure, any factor that can directly or indirectly influence behavior can potentially be utilized to reduce the frequency of accidents and fatalities. Phrasing the risk judgment in terms of how safe the slope is resulted in lower values of judged safety, which in turn resulted in a lower likelihood of deciding to ski the slope. This suggests that judging how safe a risk is will result in the safest behavior with respect to the potential risk. The safe frame was found to indirectly result in more cautious behavior via the direct effect of framing on judged safety. We illustrate the indirect influence of question framing on behavior intention via the effect on judged safety in Figure 5. This illustration is intended to make clear both the presumed cognitive processes and the potential applied relevance of question framing to the widest possible audience. By selectively phrasing the question that elicits a risk judgment, a decision maker’s attention can be directed in a way that strategically influences the perception of risk with the effect of making one behavior outcome more likely.

Interestingly, at any given level of judged safety—if participants in the two experimental groups judged safety to be the same—those prompted with the safe frame indicated that they were more likely to ski the slope than were participants prompted with the danger frame. To understand this apparently contradictory effect, consider the conditions under which judged safety will be equal between the two framing conditions. Due to the question framing effect, the judged safety of a given scenario was more likely lower under the safe frame and higher under the danger frame. That framing effect must be offset or overcome in order for judged safety between the two framing conditions to be equal. We can therefore assume that when judged safety under the two frames was equal, the perceived evidence basis for the judgments were not equivalent. The intention to ski may have been higher under the safe frame because that decision maker perceived more evidence of safety (more in terms of validity, relevance, weight, or even volume of evidence), and/or the intention to ski may be lower under the danger frame because that decision maker perceived similarly more evidence of danger. The behavior decisions under each frame are based on an asymmetry of evidence, an asymmetry that was necessary to offset the framing effect in order for judged safety to be equal. Although we appear to find more risk acceptance under the safe frame when judged safety between the experimental conditions is equal, the behavior decisions under the safe frame are potentially made on a more valid, relevant sample of evidence. Importantly, however, this finding must be placed in the context that judged safety was the strongest predictor of behavior intention. Participants who judged how safe a scenario is were more likely to judge safety as lower, and the likelihood of skiing a slope decreased as judged safety decreased. The safe frame was found to indirectly result in more cautious behavior via the direct effect of framing on judged safety.

Implications for Applied Risk Judgments and Risk Communication

Backcountry skiing in avalanche terrain exemplifies a crucial challenge in applied risk communication and risk perception: people desire to engage in an activity despite knowing the inherent risk of serious injury or death. Avalanche accidents are overwhelmingly the result of human error. In 90% of fatal avalanche accidents, the victim or someone in the victim’s party triggered the avalanche (McClung & Schaerer, 2006), implying that people’s risk perception and decisions are critical factors in avalanche fatalities. Information on the conditions in avalanche terrain such as the complex conditions of the snowpack, its metamorphosis over time, and the effects of terrain and weather, together with the knowledge of how to use this information are essential for judging avalanche risk. In an attempt to reduce the number of accidents and fatalities, stakeholders such as national avalanche warning services and education providers have done much work to provide detailed avalanche forecasts and improve public knowledge of the dangers and best practices for safety in avalanche terrain (for a review, see e.g., Engeset et al, 2018). Yet despite these efforts, avalanches continue to claim the lives of a troubling number of participants in this increasingly popular and unregulated activity. The dissemination of information—which as a stand-alone activity is a failed strategy for changing how people perceive risk and behave (Kelly & Barker, 2016; Simis et al, 2016)—has been insufficient for ensuring avalanche safety among backcountry skiers. Might question framing serve as a complementary strategy to promote more cautious risk perception and behavior?

Decision makers, avalanche warning services, and education providers have substantial control over the formulation of questions about the risks assessed during a backcountry ski tour. Our findings illustrate how the language used to formulate risk judgments and its influence on the cognitive processes has the potential for a real and tangible impact on how people perceive risk and, ultimately, behave in the face of risk. Selectively framing risk judgments might serve as one effective component of a multifaceted strategy to promote more cautious and conservative decisions in avalanche terrain and other domains involving risks. These findings have potential real-world application in teaching methods, tools, and strategies for reducing accidents and fatalities. At the public and institutional level such as a national or regional avalanche forecasting service, the frame used when presenting information about conditions in avalanche terrain might influence how users (i.e. the general public) both perceive the current risk and, more critically, how they decide to act. At the individual or group level, communication between members of a group travelling in avalanche terrain, while typically presented with little thought toward framing, could be positively impacted by increased awareness of the framing effect. Specifically, if a group member is presenting route options or tour alternatives, the way in which information and questions are framed could influence other group members' perceptions of the current risk and the decisions that are made or communicated by members of the group.

Despite the apparent promise, there are several important considerations and potential limitations for the application of question framing to increase skier safety in avalanche terrain, or to promote certain judgments and decisions within any other discipline or context. It is currently an open question whether people can prompt themselves to frame questions about risky situations in a way that promotes safer judgments, highlighting an interesting avenue for future research. It is unlikely that how a decision maker internally represents the problem or judgment is entirely determined by externally presented information and/or the formulation of the judgment task (Tversky & Kahneman, 1981). Decision makers clearly use their own experience and knowledge when modelling the world in order to judge the probabilities of potential outcomes (e.g., Wulff et al., 2019), and they may automatically do so with a familiar, default reference when not prompted with a question frame. Another important consideration is whether *actual behavior* in the mountains, when judging a slope to really ski while facing the real risk of avalanche, would be affected differently than hypothetical behavioral intent measured in an auditorium using fictional scenarios. Behavior often deviates from intention (Sheeran & Webb, 2016). Moreover, contextual cues only encountered in the natural decision environment can reduce an anticipated framing effect (Bless et al., 1998). A third consideration is that we may fail to see the same framing effect outside of the experimental setting. Unlike a natural setting, participants in our study had limited time to judge the risk and decide their behavior intention for each scenario. Although there is conflicting evidence as to whether more thought reduces framing effects (for example, see LeBoeuf & Shafir, 2003; Martiny-Huenger et al, 2020), we may fail to see the same effect in a natural environment where decision makers have more time for reflection and where the potential consequence of error is considerably greater. A fourth consideration is the necessity to establish whether people's natural decision making process is to first judge risk in terms of safety or danger before then deciding behavior. The risk judgment itself may be a contrivance of the experimental design. Outside of an experimental setting, the behavior decision may encompass the risk judgment. Finally, any application of these findings should be tested in an applied setting before prescribing them for use in practice.

Research on framing effects informs policies and practices in other applied domains such as health (e.g., Garcia-Retamero & Cokely, 2011; Garcia-Retamero & Galesic, 2010; Peters et al., 2011; Rothman & Salovey, 1997) and finance (Kirchler et al, 2005; Weber et al., 2000). Our findings highlight a promising direction for the strategic application of question framing for increased safety in various domains of applied risk perception and communication. The aim of public risk management is to optimize the decision matrix to enable users to maximize their personal enjoyment and benefit while minimizing both individual and collective public risk. Critically, as in avalanche terrain, one wants to minimize the probability that a "*go*" decision is made under objectively "*no-go*" conditions. We do not believe that the framing of risk judgment questions alone will be sufficient to ensure safe behavior among all decision makers and or in all risky domains. It is no substitute for the availability of valid evidence of the objective risk, and the necessary knowledge and experience to understand and apply that information. However, the adoption of a procedure strategy such as that afforded by framing risk judgment questions may boost an individual's overall competency for risk judgments or behavioral decisions. Various disciplines can conceivably harness the questions framing effect to make desired judgments and behaviors more likely. Risk management strategies, tools and education should recognize and account for this effect, and leverage these emergent findings to reduce the potential for accidents and fatalities.

Conclusion

The present research makes several contributions to the existing literature on framing effects. First, our research establishes the direction of the framing effect when a risk judgment is framed in terms of safety or danger. Risk judgments framed in terms of safety (*How safe is it?*) result in more cautious, conservative judgments than when framed in terms of danger (*How dangerous is it?*). Second, uncertainty was not a requirement for that effect. There was a framing effect when judging risk under varying degrees of uncertainty, be it under conditions of objective safety, uncertainty, or danger. These findings suggest that the question frame directed attention in a way that guided selective evidence sampling, rather than indicating a valence-consistent or communication-driven framing effect. Finally, our findings demonstrate the indirect influence of the question frame on behavior intention. The adoption of a procedure strategy such as that afforded by framing risk judgment questions can boost people's natural decision making competencies in order to ensure safer risk perceptions and behavior. These findings have the potential to inform the development of policies and practices that harness question framing in domains of applied risk perception and risk communication.

References

Almashat S, Ayotte B, Edelstein B, Margrett J. (2008). Framing effect debiasing in medical decision making. *Patient Education and Counseling, 71*(1):102-7. https://doi.org/10.1016/j.pec.2007.11.004

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language, 59*(4), 390-412. https://doi.org/10.1016/j.jml.2007.12.005

Biswas, D. (2009), The effects of option framing on consumer choices: Making decisions in rational versus experiential processing modes. *Journal of Consumer Behaviour, 8*(5), 284-299. https://doi.org/10.1002/cb.288

Biswas, D. and Grau, S.L. (2008), Consumer choices under product option framing: Loss aversion principles or sensitivity to price differentials? *Psychology & Marketing, 25*, 399-415. https://doi.org/10.1002/mar.20217

Bless, H., Betsch, T. and Franzen, A. (1998), Framing the framing effect: the impact of context cues on solutions to the ‘Asian disease’ problem. *European Journal of Social Psychology, 28*. 287-291. https://doi.org/10.1002/(SICI)1099-0992(199803/04)28:2<287::AID-EJSP861>3.0.CO;2-U

Block, L., & Keller, P. (1995). When to Accentuate the Negative: The Effects of Perceived Efficacy and Message Framing on Intentions to Perform a Health-Related Behavior. J*ournal of Marketing Research, 32*(2), 192-203. https://doi.org/10.2307/3152047

Bruine de Bruin, W. (2011). Framing effects in surveys: How respondents make sense of the questions we ask. In G. Keren (Ed.), *Perspectives on Framing*. (pp. 3-33). New York, NY, US: Psychology Press.

Bruine de Bruin, W., van der Klaauw, W., Topa, G., Downs, J. S., Fischhoff, B., & Armantier, O. (2012). The effect of question wording on consumers' reported inflation expectations. *Journal of Economic Psychology, 33*(4), 749-757. https://doi.org/10.1016/j.joep.2012.02.001

Bui, T. C., Krieger, H. A., & Blumenthal-Barby, J. S. (2015). Framing Effects on Physicians' Judgment and Decision Making. *Psychological Reports, 117*(2), 508–522. https://doi.org/10.2466/13.PR0.117c20z0

Cacciatore, M. A., Scheufele, D. A., & Iyengar, S. (2016). The End of Framing as we Know it … and the Future of Media Effects. *Mass Communication and Society, 19*(1), 7-23. https://doi.org/10.1080/15205436.2015.1068811

Chong, D., & Druckman, J. N. (2007). Framing Theory. *Annual Review of Political Science, 10*(1), 103-126. doi:10.1146/annurev.polisci.10.072805.103054

Christensen, R. H. B. (2019). *ordinal - Regression Models for Ordinal Data* (Version 2019.4-25). http://www.cran.r-project.org/package=ordinal/

Comerford, D. A., and Robinson, J. (2017) Die-by Framing both Lengthens and Shortens Life: Further Evidence on Constructed Beliefs in Life Expectancy. *Journal of Behavioral Decision Making*, 30: 1104– 1112. https://doi.org/10.1002/bdm.2027

Druckman, J. N. (2001). Evaluating framing effects. *Journal of Economic Psychology, 22*(1), 91-101. https://doi.org/10.1016/S0167-4870(00)00032-5

Engeset, R. V., Pfuhl, G., Landrø, M., Mannberg, A., & Hetland, A. (2018). Communicating public avalanche warnings – what works? *Natural Hazards and Earth System Sciences, 18*(9), 2537-2559. https://doi.org/10.5194/nhess-18-2537-2018

Garcia-Retamero, R., & Cokely, E. T. (2011). Effective communication of risks to young adults: Using message framing and visual aids to increase condom use and STD screening. *Journal of Experimental Psychology: Applied, 17*(3), 270–287. https://doi.org/10.1037/a0023677

Garcia-Retamero, R., & Dhami, M. K. (2013). On avoiding framing effects in experienced decision makers. *Quarterly Journal of Experimental Psychology, 66*(4), 829-842. https://doi.org/10.1080%2F17470218.2012.727836

Garcia-Retamero, R., & Galesic, M. (2010). Who profits from visual aids: overcoming challenges in people's understanding of risks [corrected]. *Social Science & Medicine, 70*(7), 1019-1025. https://doi.org/10.1016/j.socscimed.2009.11.031

Grice, H. P. (1975). Logic and conversation. In P. Cole & J. L. Morgan (Eds.), *Syntax and semantics. Volume 3: Speech acts* (pp. 41–58). New York: Academic Press.

Hedger, N., Gray, K. L. H., Garner, M., & Adams, W. J. (2016). Are visual threats prioritized without awareness? A critical review and meta-analysis involving 3 behavioral paradigms and 2696 observers. *Psychological Bulletin, 142*(9), 934-968. http://dx.doi.org/10.1037/bul0000054

Hilton, D. J. (2011). Linguistic polarity, outcome framing, and the structure of decision making: A pragmatic approach. In G. Keren (Ed.), *Perspectives on Framing*. (pp. 135-155). New York, NY, US: Psychology Press.

Hogarth, R. M., Lejarraga, T., & Soyer, E. (2015). The two settings of kind and wicked learning environments. *Current Directions in Psychological Science*, *24*(5), 379-385. https://doi.org/10.1177/0963721415591878

Hohle, S. M., & Teigen, K. H. (2018). More than 50% or Less than 70% Chance: Pragmatic Implications of Single-Bound Probability Estimates. *Journal of Behavioral Decision Making*, *31*(1), 138-150. https://doi.org/10.1002/bdm.2052

Holleman, B. (2006). The meanings of “yes” and “no”. An explanation of the forbid/allow asymmetry. *Quality and Quantity*, *40*, 1–38. https://doi.org/10.1007/S11135-005-4479-6

Kahneman, D., & Tversky, A. (1984). Choices, values, and frames. *American Psychologist*, *39*(4), 341–350. https://doi.org/10.1037/0003-066X.39.4.341

Kelly, M. P., & Barker, M. (2016). Why is changing health-related behaviour so difficult? *Public Health, 136*, 109-116. https://doi.org/10.1016/j.puhe.2016.03.030

Keren, G. (2011). On the definition and possible underpinnings of framing effects: A brief review and a critical evaluation. In G. Keren (Ed.), *Perspectives on Framing*. (pp. 3-33). New York, NY, US: Psychology Press.

Kirchler, E., Maciejovsky, B., & Weber, M. (2005). Framing Effects, Selective Information, and Market Behavior: An Experimental Analysis. *Journal of Behavioral Finance*, *6*(2), 90-100. https://doi.org/10.1207/s15427579jpfm0602_4

Kreiner, H., & Gamliel, E. (2018). The Role of Attention in Attribute Framing. *Journal of Behavioral Decision Making, 31*(3), 392-401. https://doi.org/10.1002/bdm.2067

Kühberger, A. (1998). The Influence of Framing on Risky Decisions: A Meta-analysis. *Organizational Behavior and Human Decision Processes, 75*(1), 23-55. https://doi.org/10.1006/obhd.1998.2781

Kühberger, A. (2017). Framing. In R. F. Pohl (Ed.), *Cognitive illusions: Intriguing phenomena in thinking, judgment and memory, 2nd ed.* (pp. 79-98). New York, NY, US: Routledge.

LeBoeuf, R. A., & Shafir, E. (2003). Deep thoughts and shallow frames; on the susceptibility to framing effects. *Journal of Behavioral Decision Making, 16*(2), 77–92. https://doi.org/10.1002/bdm.433

Levin, I. P. (1987). Associative effects of information framing. *Bulletin of the Psychonomic Society, 25*(2), 85-86. https://doi.org/10.3758/BF03330291

Levin, I. P., & Gaeth, G. J. (1988). How Consumers are Affected by the Framing of Attribute Information Before and After Consuming the Product. *Journal of Consumer Research, 15*(3), 374-378. https://doi.org/10.1086/209174

Levin, I. P., Schneider, S. L., & Gaeth, G. J. (1998). All Frames Are Not Created Equal: A Typology and Critical Analysis of Framing Effects. *Organizational Behavior and Human Decision Processes, 76*(2), 149-188. https://doi.org/10.1006/obhd.1998.2804

Martiny-Huenger, T., Bieleke, M., Doerflinger, J., Stephensen, M. B., & Gollwitzer, P. M. (2020). Deliberation decreases the likelihood of expressing dominant responses. *Psychonomic Bulletin & Review*. https://doi.org/10.3758/s13423-020-01795-8

Maule, J., & Villejoubert, G. (2007). What lies beneath: Reframing framing effects. *Thinking & Reasoning, 13*(1), 25-44. https://doi.org/10.1080/13546780600872585

McClung, D. & Schaerer, P.A. (2006). *The Avalanche Handbook*. Seattle, WA: The Mountaineers Books.

McKenzie, C. R. M. (2004). Framing effects in inference tasks—and why they are normatively defensible. *Memory & Cognition, 32*(6), 874-885. https://doi.org/10.3758/BF03196866

McKenzie, C. R. M., & Nelson, J. D. (2003). What a speaker's choice of frame reveals: Reference points, frame selection, and framing effects. *Psychonomic Bulletin & Review, 10*(3), 596-602. https://doi.org/10.3758/bf03196520

Nelson, T. E., Oxley, Z. M., & Clawson, R. A. (1997). Toward a Psychology of Framing Effects. *Political Behavior, 19*(3), 221-246.https://doi.org/10.1023/A:1024834831093

Payne, J.W., Sagara, N., Shu, S.B. *et al.* (2013) Life expectancy as a constructed belief: Evidence of a live-to or die-by framing effect. *Journal of Risk and Uncertainty,* 46**,** 27–50. https://doi.org/10.1007/s11166-012-9158-0

Peters, E., Hart, P. S., & Fraenkel, L. (2011). Informing patients: the influence of numeracy, framing, and format of side effect information on risk perceptions. *Medical Decision Making, 31*(3), 432-436. https://doi.org/10.1177/0272989x10391672

Piñon, A., & Gambara, H. (2005). A meta-analytic review of framing effect: Risky, attribute and goal framing. *Psicothema, 17*(2), 325-331.

R Core Team (2017). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing, Vienna, Austria.

Rothman, A. J., & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: The role of message framing. *Psychological Bulletin, 121*(1), 3-19. https://doi.org/10.1037/0033-2909.121.1.3

Scheufele, D.A. and Tewksbury, D. (2007), Framing, Agenda Setting, and Priming: The Evolution of Three Media Effects Models. *Journal of Communication, 57*(1), 9-20. https://doi.org/10.1111/j.0021-9916.2007.00326.x

Sheeran, P., and Webb, T. L. (2016) The Intention–Behavior Gap. *Social and Personality Psychology Compass*, 10, 503– 518. https://doi.org/10.1111/spc3.12265

Sher, S., & McKenzie, C. R. M. (2006). Information leakage from logically equivalent frames. *Cognition, 101*(3), 467-494. https://doi.org/10.1016/j.cognition.2005.11.001

Sieck, W., & Yates, J. F. (1997). Exposition effects on decision making: Choice and confidence in choice. *Organizational Behavior and Human Decision Processes, 70*(3), 207–219. https://doi.org/10.1006/obhd.1997.2706

Simis, M. J., Madden, H., Cacciatore, M. A., & Yeo, S. K. (2016). The lure of rationality: Why does the deficit model persist in science communication? *Public Understanding of Science, 25*(4), 400-414. https://doi.org/10.1177/0963662516629749

Simon, A.F., Fagley, N.S. and Halleran, J.G. (2004), Decision framing: moderating effects of individual differences and cognitive processing. *Journal of Behavioral Decision Making, 17*, 77-93. https://doi.org/10.1002/bdm.463

Teigen, K. H. (2015). Framing of Numerical Quantities. In G. Keren & G. Wu (Eds.), *The Wiley Blackwell Handbook of Judgment and Decision Making* (pp. 568-589). West Sussex, UK: John Wiley & Sons.

Teigen, K. H., Halberg, A.-M., & Fostervold, K. I. (2007). Single-limit interval estimates as reference points. *Applied Cognitive Psychology, 21*(3), 383-406. https://doi.org/10.1002/acp.1283

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science, 211*(4481), 453-458. https://doi.org/10.1126/science.7455683

Weber, M., Keppe, H.-J., & Meyer-Delius, G. (2000). The impact of endowment framing on market prices — an experimental analysis. *Journal of Economic Behavior & Organization, 41*(2), 159-176. https://doi.org/10.1016/S0167-2681(99)00092-X

Wulff, D., Markant, D., Pleskac, T. J., & Hertwig, R. (2019). Adaptive exploration: What you see is up to you. In R. Hertwig, T. Pleskac, T. Pachur, & the Center for Adaptive Rationality (Eds.), *Taming Uncertainty* (pp. 131–152). Boston, MA: MIT Press.