Chapter 2

Are people interested in probabilities of natural disasters?

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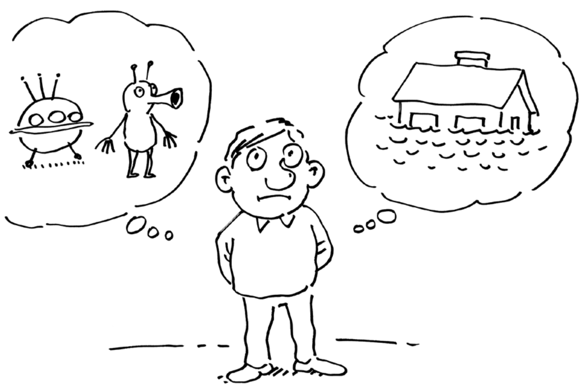
2.1 INTRODUCTION[1]



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Analysis of the decision-making of individuals facing risk or uncertainty is one of the core research issues in the domain of decision theory. Since Blaise Pascal, all decision theorists assume that, when faced with a number of possible actions, two things are important for a decision-maker (DM): the utilities of possible outcomes and their probabilities (Lowenstein *et al.* 2001). However, several empirical studies show that people generally have problems in understanding and using probabilistic information (Tyszka & Sawicki, 2011), and when facing risky decisions they are often not interested in receiving information about probabilities (Huber *et al.* 1997; Huber *et al.* 2001; Lion *et al.* 2002; Tyszka & Zaleskiewicz, 2006; Amelung & Funke, 2015).

In particular this is the finding from the studies of naturalistic decision-making that apply active information search (AIS) as a method of information seeking and decision process tracing. This method, originally proposed by Engländer and Tyszka (1980) and further developed by Huber and colleagues (Huber, 1997; Huber *et al.* 1997), relies on the following procedure: a DM gets a minimal description of the decision task, presented in the form of a pseudo-realistic scenario, and has to ask questions to obtain the additional information that they think is necessary to make a decision. The main purpose of this method is to analyze real-life decision problems as opposed to artificial choices among gambles – a traditional method of testing decision theory where a DM receives complete information consisting of the outcomes of each gamble and their probabilities. The most pervasive finding of Huber and colleagues is that for pseudo-naturalistic scenarios only a minority of individuals are interested in probabilities. Instead, they look for risk defusing operators (RDOs), which are actions planned in addition to a choice alternative in order to defuse possible negative consequences (Huber *et al.* 1997; Huber *et al.* 2001; Huber & Huber, 2008; Huber *et al.* 2011). The existence of RDOs changes the perceived riskiness of available options, which in turn influences the final decision (Amelung & Funke, 2015).

Huber (1997) attributes differences between lottery-type tasks and naturalistic decision-making to differences in the controllability of the occurrence of the risky events at issue. While in gambles the outcomes are completely beyond the DM's control, in many naturalistic situations the DM either has (at least partial) control or believes they have control over the situation. Such control permits precautions to be taken against the occurrence of negative consequences (thus reducing their probability), and/or the making of a plan of action to deal with any negative consequences. For example, in the 'machine task' subjects planned to perform good machine maintenance to decrease the probability of machine breakage (Huber *et al.* 1997).

In their research, Huber and colleagues have mainly concentrated on naturalistic situations in which the DM possesses control over the occurrence of risky events (Huber, 1997; Huber *et al.* 1997). However, there are naturalistic situations in which a DM cannot influence the occurrence of a risky event. This is particularly true for natural disasters, which are the focus of this paper. Natural disasters constitute large-scale risks that are beyond human control and cause great damage or loss to physical capital (e.g., housing or productive capacity), and/or human capital (e.g., lives or physical health). Risks of this type are characterized by two features: (a) they occur relatively rarely, that is their probability is rather low, and (b) they have highly negative consequences (they are catastrophic). Although natural disasters cannot be prevented, one can still try: (1) to anticipate them, and (2) to undertake actions aimed at reducing their negative consequences. We tested the hypothesis that pseudo-realistic scenarios which dealt with natural hazards would evoke higher interest in probabilities among our participants in comparison to naturalistic situations in which DMs had control over the occurrence of a negative event (as researched by Huber and colleagues).

Our second aim was to discover which other factors apart from controllability might have an impact on subjects' interest in probabilities and RDOs. We thought that one such factor might be the importance or significance of a particular decision to the DM. We chose two operationalizations of a decision's significance: (1) the possible consequences of a natural disaster, namely loss of life versus loss of physical capital, and (2) whether the decision was being taken for oneself or for others. We believed that when a decision is more important for a DM it is natural that they will be more interested in it, and will generally tend to collect more information about the decision situation, including information about probabilities and information on possible ways of diffusing risks. The rationale for this hypothesis is reasonably straightforward when the importance of a decision problem is operationalized in terms of a natural disaster's consequences: a life-threatening situation should be considered as more important than a capital-threatening situation. Thus, in comparison to the latter case, we expected subjects to collect more information about the decision situation in general and also more information on probabilities and RDOs in the former case.

The rationale for the hypothesis concerning how much information is collected when a DM is making a decision impacting on themselves in comparison to making a decision impacting on others is even more straightforward: it is natural to assume that the DM should consider the former types of decision as more important than the latter. This suggests that, relative to decisions affecting others, in decisions involving the self the DM should collect more information in general about the decision situation, including information about probabilities and information on RDOs. At the same time, Stone and Allgaier's (2008) social values theory suggests that, when taking decisions involving others, people mainly act in accordance with the social value placed on the risk involved in a specific situation. Specifically, in situations concerning individual physical safety, social value is placed on risk avoidance. Thus, in such situations, instead of considering all factors, the DM simply 'follows a norm to make the socially-sanctioned decision for the other person' (Stone *et al.* 2013; p. 251). In contrast, when deciding for oneself, a host of factors are considered and all the pros and cons of each specific decision are weighed. In line with this, Stone *et al.* (2013) report that, in situations involving potentially serious physical harm, decisions taken for the self are more risky than decisions taken for others. Thus, we assumed that when taking decisions involving others a DM should consider fewer factors and therefore ask fewer questions than when taking decisions involving themselves. So, instead of thoroughly analyzing a situation, the DM should almost immediately reject the risky option and therefore omit looking for information about different aspects of the situation, including probabilities and RDOs. Social values theory reinforces our hypothesis that the DM should be interested in collecting more information in general, as well as more information on RDOs and probabilities, when taking decisions involving themselves than when taking decisions involving others.

Finally, the present research addressed the relationship between risk aversion and information search in the context of negative events' probabilities. By definition, people who are more risk-averse are generally more interested in avoiding risky situations, or, when this is not possible, in reducing the risk inherent in situations. Thus, they should be more interested both in knowing the probability of a negative event and in knowing information about possible RDOs. Therefore, we tested the hypothesis that the more risk-averse a person is, the more they should be interested in the probabilities of negative events and in RDOs. To the best of **our knowledge** this is the **first study** investigating the relationship between individual risk attitudes and information search in the domain of probabilities concerning negative events.

2.2 METHOD

2.2.1 Subjects

In total, 116 students and non-students of different professions took part in the study. Of these, 68 were females and 48 were males, with a mean age of 25.72 years ($SD = 4.36$). Participants were recruited using the Online Recruitment System for Economic Experiments (ORSEE) (Greiner, 2015). None of them had previously taken part in a similar experiment. For their participation subjects could receive up to 58.5 PLN (13.81 EUR): 20 PLN (4.72 EUR) in the main task and maximally 38.5 PLN (9.08 EUR) in the risk aversion measurement task. Although no time limit was imposed, participants needed 30 minutes at most to complete all experimental tasks.

2.2.2 Decision scenarios

Experimental manipulation used four quasi-realistic scenarios with a mudslide as our choice of natural disaster. At the end of all four scenarios, subjects were presented with two choice alternatives: a non-risky alternative with certain positive and negative consequences and a risky alternative. The scenarios are described below:

You live in a spacious house with a garden. You simply love your house. However, the house is located on a hillside where, in the past, mudslides occurred. Recently, rainfall increased and the occurrence of mudslides grew.

With concerns about residents' safety, local authorities offer people living in the affected area relocation. In return, they offer those homeowners who agree to relocate another house free of charge in a new neighborhood; yet this house is a little less attractive. So you have a choice: either to stay in your old house, or to move to the new house.

The scenarios differed in two aspects. First, they differed in the type of possible damage: whether they put life or capital in danger. In the 'life-threatening' scenarios, subjects were informed that mudslides had previously killed several people, and by deciding to stay in their old house they exposed themselves to the danger of also being killed by a mudslide. In the 'capital-threatening' scenarios, subjects were informed that although mudslides occur at a speed enabling evacuation of people, they completely destroy affected houses. Thus, in this case a person risks losing all of their material possessions, but not their life. The second aspect concerned the object of the decision, namely whether the decision was being taken for the subject themselves or for others. As the name suggests, in the case of the 'self' manipulation a participant took a decision for themselves. In the case of the 'others' manipulation a subject took the role of a charity organization representative who had to advise an old couple as to the decision they should take in the situation described in the scenario. Detailed descriptions of the four scenarios are in Appendix A.

A 'Virus infection' scenario from Bär and Huber (2008) was used as a warm-up exercise. In this scenario, a subject took the role of a vacationer in an unknown country who was infected with a dangerous virus and who had to decide about their treatment (see Appendix B for a description of the warm-up task).

2.2.3 Experimental procedure

To analyze the information search process, we used the AIS paradigm which involves a subject receiving a minimal description of a decision task presented in the form of a scenario and then having to acquire additional information from the experimenter. In order to be able to answer most of our subjects' questions we ran several pre-experimental sessions with large groups of subjects in which we collected an extensive (but not exhaustive) list of possible questions. Standardized answers for these questions were prepared.

Each subject was interviewed individually in the experiment. They started with the warm-up exercise and then were randomly assigned to one of the four experimental scenarios. After reading both the warm-up and the experimental scenario an individual could ask the experimenter questions. The experimenter read an answer from the previously prepared list of standardized answers. All interviews were tape-recorded. Once the interview was completed subjects performed Holt and Laury's (2002) lottery-task (with stakes 10 times greater than in the original Holt and Laury experiment). In this task subjects make 10 choices between 2 lotteries: a 'safe' lottery (A) and a 'risky' lottery (B) – see Appendix C. The switching point between lottery A and lottery B was used as our first operationalization of subjects' individual risk attitudes.

One of the main disadvantages of complex methods of eliciting risk preferences such as the Holt and Laury lottery-task is that, depending on the population, a significant number of subjects often fail to understand the procedure (Charness *et al.* 2013). Thus, we used an additional operationalization of risk attitude: as part of a post-experimental questionnaire, subjects were asked to assess their general desire to take risks on a scale from zero to 10 (see Appendix D). A debriefing procedure and payment followed.

2.3 RESULTS

2.3.1 Data classification

First, we created eight categories for questions' classification: six of them were taken from the previous work of Huber *et al.* (2011); two were our own categories. All categories are defined in Table 2.1.

To test the reliability of the coding of questions, 100 randomly chosen questions were categorized independently by three raters. There was 94% agreement between the three raters.

2.3.2 Hypothesis testing

In total, the 116 participants generated 772 questions ($M = 6.66$ per participant). Almost 40% of questions were in the 'consequences' category, the least number of questions (1.9%) were in the 'new alternative' category. The distribution of the total number of questions per category can be seen in Figure 2.1.

Formal tests of the hypotheses concerning the information search process based on scenario type and subjects' risk aversion are now presented.

2.3.2.1 Controllable versus uncontrollable scenarios

We start by comparing our results to those of Huber and colleagues (henceforth called Huber's experiments). We hypothesized that in our experiment significantly more questions would be asked about, or more subjects would be interested in, the probability category than in Huber's experiments. (Values are taken from different publications of Huber and colleagues; not every publication reported both variables of current interest.) Since we found no significant differences between the information search patterns for 'the self' and 'others' scenarios, we analyzed these two groups jointly (for more details refer to the Importance of decision section). Table 2.2 presents the average number of questions per participant (M) which fell into the probability category in our experiment and in several of Huber's experiments, sample sizes are also given. Average values are reported separately for the 'life' and 'house' experimental scenarios along with average values over all scenarios (Total).

Table 2.1 Categories used in data classification.

Nr	Category	Definition	Abbreviation
1	General situational information	Questions aimed at investigating the general decision situation. Questions concerning: background, the role of the decision-maker, the circumstances of the decision, and the situation.	GSI
2	Consequences	Refers to the outcomes of alternatives or to attributes of alternatives.	C
3	Probability/frequency	Questions demanding information about the probability or frequency of the risky event, consists of two subcategories – probability/frequency of loss and probability/frequency of a mudslide.	P/F
3.2	Probability/frequency of loss	Refers to questions concerning the amount of material and human loss connected to the dangerous situation, as well as the probability that this loss might occur.	–
3.3	Probability/frequency of a mudslide	Refers to questions concerning frequency, probability and forecasts of mudslides' occurrence in the past and in the future.	–
4	New alternative	Questions about additional alternatives not included in the presented set, or suggestions of new alternatives and enquiries about whether these alternatives are available. In contrast to RDO questions, NA questions are not aimed at actions that are intended to be performed in addition to the existing alternative.	NA
5	Risk diffusing operator	Refers to information concerning the control or prevention of negative consequences by actions that are executed in addition to choosing the existing alternative.	RDO
6	Search for opinions of others	Refers to opinions of others, decisions of neighbors or other people, desire to consult others before taking decision.	SOO
7	Information about the risky situation	Questions aimed at understanding the disaster's character/nature (e.g., what is a mudslide; when does it occur; meteorological issues connected to mudslide occurrence); circumstances that increase the feeling of risk (e.g., how close to my house was the house damaged by the last mudslide); damage a current house might undergo or has undergone as a consequence of mudslides.	RSI
8	Irrelevant (miscellaneous)	Questions that contain no information needed for taking decisions in our task.	I

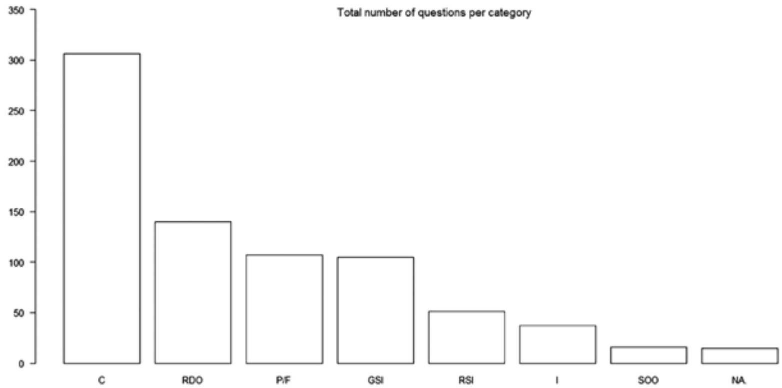

Figure 2.1 Distribution of questions per category.

The values in Table 2.2 show that, on average, participants in our experiment asked more questions concerning probabilities than in Huber's experiments. When Huber and colleagues used the classic AIS method, that is, the standard AIS experimental procedure without any additional manipulations, they always received fewer questions about probabilities than in our experiment. The closest of Huber's results to ours are those of Huber *et al.* (2009) where: (1) the problem in the experiment was more serious in comparison to other experiments by Huber's team (here, a subject had to decide for their partner, who was in a life-threatening condition, which of two available medicines they should be treated with. Both medicines had severe side effects. See Huber *et al.* (2009) for a detailed description.); (2) a serious decision was to be taken for another person; (3) a critical situation had occurred, so the control factor was missing as in our study, and (4) an additional 'justification of choice' manipulation was introduced – namely, after choosing one of two decision options, a subject had to explain and justify their decision.

Table 2.2 Average number of questions in the probability category per experiment.

Scenarios/Paper	***M***	***CI*$_{95}$**	***N***	**Notes**
Life scenarios	1.05	[0.74, 1.36]	58	–
House scenarios	0.80	[0.45, 1.14]	58	–
Total	0.92	[0.69, 1.15]	116	–
Huber (2007)	0.55	–	42	Classic AIS
Huber *et al.* (2009)	0.60	–	30	Classic AIS
Huber *et al.* (2009)	0.73	–	30	Justification of choice manipulation

Next we compared the number of participants asking at least one question in the probability category in our experiment and in Huber's experiments. Table 2.3 presents percentages of subjects asking at least one probability question for the life and house scenarios separately and an average value over all scenarios (Total). Sample sizes are also given. The table also includes one-sided probability values for Pearson Chi-squared tests comparing the total number of people asking at least one probability question in each of Huber's experiments and our experiment. These values show that significantly more subjects asked at least one probability question in our experiment compared to classic AIS studies. As previously, the most interesting case is the experiment of Huber *et al.* (2009) which used a serious experimental problem that had to be solved for another person and where outcomes were beyond participants' control. A comparison of our results with those of a condition in this study that did not include any additional manipulation revealed that in our experiment significantly more people asked at least one question about probabilities in life scenarios, but not in house scenarios; however introduction of the justification of choice manipulation changed the situation, significantly more subjects in Huber's experiment showing interest in probabilities than with all our treatments.

Individual effect sizes (odds ratios) for classic AIS studies (see Table 2.2) also suggest that the odds of asking at least one probability question were consistently and significantly higher in our experiment than in Huber's experiments. Since samples from Huber experiments were rather small, we aggregated evidence from individual studies into a summary (mean) effect (Table 2.2, Total). The magnitude of this estimated summary effect confirms that, in comparison with Huber's three experiments, the odds of asking probability questions in our experiment were 2.55 (1.71, *inf*) times higher, and ranged from 1.73 (1.11, *inf*) times higher in house scenarios to 3.72 (2.40, *inf*) times higher in life scenarios.

We conclude that our first hypothesis is supported since when; (1) occurrence of a negative event is beyond participants' control, and (2) no additional manipulations are introduced, participants do demonstrate more interest in the probability category.

2.3.2.2 Importance of decision

We then tested the hypothesis concerning differences in information search patterns according to decisions' importance. Starting with the self versus others operationalization of decision importance, there was neither a significant difference between experimental scenarios in the total amount of questions asked, nor in the number of questions in the specific RDO and probability categories. Also, there was no difference between scenarios in the number of participants who asked at least one probability question (see Appendix E). Therefore there was no support for the hypothesis that information search would be greater for more important self-decisions.

Table 2.3 Subjects asking at least one question in the probability category.

Scenario/Paper	%	CI_{95}	*N*	*p* One-Sided	Odds Ratio	$CI_{95,One\text{-}Sided}$	Notes
Life scenarios (a)	58.62	[45.56, 71.68]	58	–	–	–	–
House scenarios (b)	39.66	[26.68, 52.63]	58	–	–	–	–
Total (c)	49.14	[39.90, 58.37]	116	–	–	–	–
Huber *et al.* (1997)	21.75	–	36	0.00 (a) 0.04 (b) 0.00 (c)	4.96 2.30 3.38	[2.25, *inf*] [1.04, *inf*] [1.54, *inf*]	Classic AIS
Huber (1997)	25	–	40	0.00 (a) 0.06 (b) 0.01 (c)	4.25 1.97 2.90	[2.02, *inf*] [0.94, *inf*] [1.38, *inf*]	Classic AIS
Huber *et al.* (2009)	36.7	–	30	0.03 (a) 0.39 (b) 0.11 (c)	2.45 1.14 1.67	[1.14, *inf*] [0.53, *inf*] [0.78, *inf*]	Classic AIS
Total (*fixed effect*)[a]					3.72 (a) 1.73 (b) 2.55 (c)	[2.40, *inf*] [1.11, *inf*] [1.71, *inf*]	Classic AIS
Huber *et al.* (2009)	53.5	–	30	0.32 (a) 0.11 (b) 0.34 (c)	1.24 0.58 0.85	[0.59, *inf*] [0.27, *inf*] [0.40, *inf*]	Justification of choice manipulation

Note: [a]In estimating the summary effect size we faced the problem that only a small number of studies were included in the analysis. In such cases, Borenstein *et al.* (2009) suggest estimating a fixed effect model. Choice of this model was also supported by the absence of heterogeneity in the effect size distribution: (a) Chi-square(2) = 1.26, $p = 0.53$; (b) Chi-square(2) = 1.25, $p = 0.53$; (c) Chi-square(2) = 1.52, $p = 0.47$.

We now consider the type of damage (life versus house) operationalization of importance.

Number of questions: Significantly more questions were asked in the two life scenarios (438) than in the two house scenarios (334), Mann-Whitney $U = 2051$, $p = 0.02$, one-sided, supporting the hypothesis that there would be more interest in information collection for the more important type of damage.

Probability questions: Next we compared the number of probability questions asked for the life and house scenarios. All three categories of probability/frequency items were analyzed:

(1) Probability/frequency of loss;
(2) Probability/frequency of a mudslide;
(3) A joint category of probability of loss and a mudslide.

The first row of Table 2.4 presents results for questions relating to each probability category across the two experimental scenarios, including significance levels associated with Pearson Chi-squared tests. Findings showed that significantly more questions were asked in the joint category for life scenarios compared to house scenarios. This result was influenced by the highly significant difference in the number of probability/frequency of loss questions for the two scenarios.

Table 2.4 Categories of probability questions (L and H indicate life and house respectively).

	Probability Joint			Probability of Loss			Probability of a Mudslide		
	N_L	N_H	*p* One-Sided	N_L	N_H	*p* One-Sided	N_L	N_H	*p* One-Sided
Number of probability questions	61	46	0.037	28	11	0.004	33	35	0.363
Subjects asking at least one question about probabilities	34	23	0.021	21	8	0.003	26	22	0.226

Moving on to consider whether there was a difference between the two scenario types in the number of subjects who asked at least one probability/frequency question, the second row of Table 2.4 shows that significantly more participants asked at least one probability question in the 'probability joint' category in life scenarios than in house scenarios. This result was influenced by the highly significant difference in the number of subjects asking at least one question in the 'probability of loss' category for the two scenarios.

We conclude that the 'probability of a mudslide' category was of equal importance in both scenarios (in total 68 questions or 48 people), but that 'probability of loss' was a more important category in life than in house scenarios (in total 39 questions or 29 people).

RDOs: For the RDO category there was no significant difference between the life and house scenarios (79 versus 61; Mann-Whitney $U = 1876$; $p = 0.129$, one-sided). Therefore we conclude that level of interest in RDOs was not connected with disaster type.

2.3.2.3 Risk aversion

Finally, we performed analyses to consider whether risk aversion might influence information search in the RDO and 'probability/frequency' categories. Using the sum of A choices participants made in the Holt and Laury (2002) task as a measure of risk aversion, the mean risk aversion score was 5.38 ($SD = 1.82$). There was no correlation between number of questions asked in the joint probability category and risk aversion ($r_\tau = 0.05$, $p = 0.589$, two-sided); however the correlation between the measure of risk aversion and number of questions asked in the probability of loss category was only marginally non-significant ($r_\tau = 0.15$, $p = 0.089$, two-sided). According to Cohen's (1988) standard classification, correlations between 0.1 and 0.3 are deemed small. Contrary to our hypothesis, more risk-averse subjects showed less interest in obtaining information about RDOs ($r_\tau = -0.14$, $p = 0.088$, two-sided). Additionally, we analyzed whether individual risk attitude might generally motivate subjects to look more thoroughly/longer for situational information, but the correlation between risk aversion and number of questions asked in the experiment was virtually zero ($r_\tau \approx 0.00$, $p = 0.984$, two-sided).

As mentioned above, we used a second operationalization of individual risk aversion: reported attitude towards risk. Our risk measures were weakly, but significantly, correlated ($r_\tau = 0.28$, $p < 0.001$, two-sided), and the second risk aversion measure was not correlated with our categories of interest (RDOs: $r_\tau = -0.07$, $p = 0.30$, two-sided; probability: $r_\tau = -0.07$, $p = 0.40$, two-sided; probability of loss: $r_\tau = 0.02$, $p = 0.80$, two-sided).

We conclude that, although risk aversion might have played some role in information search procedures in our experiment, our operationalizations of risk aversion were not good enough to draw any sound conclusions as to the existence and direction of any connections.

2.3.2.4 Gender

There were no significant differences between male and female participants for any of the variables of interest (see Appendix F).

2.4 DISCUSSION

Prior research on human decision-making in risky situations has shown that people show little interest in information about probabilities of the possible outcomes of their decisions. Huber and colleagues (Huber *et al.* 1997; Huber *et al.* 2001), who created a special framework for studying naturalistic risky situations, suggested that most people will use probabilistic information only if they are presented with it. They claim that this minor role of probabilities in people's decision-making processes is because people look for RDOs instead of estimating probabilities. Huber *et al.* (1997) contrasted standard lottery-type tasks, in which the DM has no control over the occurrence of a particular outcome, with controllable naturalistic situations, and suggested that the crucial factor leading to the lack of interest in probabilities is controllability over risky situations.

Following this assumption, our research focused on specific naturalistic situations in which individuals could exert no control over threatening events, namely natural disasters. Results showed that, in naturalistic situations of this type, interest in obtaining probabilistic information substantially increases compared to situations in which control over the occurrence of threatening events is possible: almost half of our participants requested information on probabilities. There is good reason to expect such interest to be even higher in non-hypothetical situations of this type. When we compared participants' interest in probabilities in our study and in Huber's experiments conducted using the same procedure as ours, we found that our subjects asked more questions about probability. Thus, Huber's claim that people have little interest in probabilities in naturalistic situations should be limited to situations in which people can control the occurrence of threatening events: his claim does not hold in situations connected with natural disasters, where no control is possible.

Interestingly, even in situations where people had limited control over threatening events and where increased interest in probabilities was observed, individuals still searched for information about available RDOs. Moreover, RDOs proved to be the second most frequently searched category, after the consequences category; the probability category being the third most popular. This is in line with the findings of Lion *et al.* (2002) that almost twice as many participants wanted information about the risk controllability as about the probability of the negative consequences of that risk. Perhaps this behavior stems from the illusion of control phenomenon, (Langer, 1975) which usually manifests itself in a person overestimating their control over events that are actually beyond their control.

The above-mentioned findings have important implications. Although it is useful, Huber's contrasting of naturalistic risky decision situations with lottery-type tasks has important limitations. After all, lottery-type tasks are representative of a certain type of naturalistic risky situation, namely those in which the DM has no control over the occurrence of risky events, natural disasters being but one example of such situations. Another good example is stock-market investor behavior, an investor being unable to directly control the probabilities of their stocks' price fluctuations. Thus, we can expect that inhabitants of areas exposed to natural disasters (floods, earthquakes, etc.) would be highly interested in knowing how often these catastrophic events occur and, similarly, an investor would be keen to acquire information on the probabilities of price changes of specific stocks before including them in their portfolio. On the other hand, a decision about operating a business constitutes an example of a situation which allows an entrepreneur direct control of the probability of success of their venture: in this case they can apply a number of RDOs that allow them to keep the chances of the business becoming bankrupt under control. In this situation we would expect entrepreneurs to demonstrate more interest in available RDOs than in knowing the precise probability of bankruptcy for their type of business.

As previously discussed, we found that our subjects systematically asked more probability-related questions compared to the research of Huber and colleagues. The only exception to this pattern was the aspect of the Huber *et al.* (2009) study where an additional justification of choice manipulation was added to the procedure. In this case, Huber's subjects had significantly higher interest in probability items. We posit that, in general, a justification of choice manipulation induces more questions to be asked by creating two aims for information search. The first aim is to make an informed decision between the two available choice options and the second aim is to come up with a good justification for the particular option chosen. This naturally leads to a more active search for probability and frequency items, since numerical information represents a sound justification for virtually every decision (Stamper, 2001).

Our study also showed that people are more interested in probabilities when a choice is of relatively high importance, operationalized here in terms of a natural disaster's consequences: we found a significant difference in the number of questions asked about probabilities in life-threatening situations compared to capital-threatening situations. Interestingly, we also found that in total subjects collected more situational information in the more important (life-threatening) situation. This demonstrates that subjects are not only interested in obtaining information about the object of their interest, but that they also actively engage in information search about the risks of damage or destruction to that object, and interest in such probabilistic information increases as the object's importance increases. However, we detected no difference in the number of RDO questions asked for the life and house scenarios. At this stage of our research we can only speculate that there should be a difference between life- and capital-threatening situations in the case of more controllable scenarios (e.g., situations such as man-made disasters as opposed to natural disasters). This is ultimately an empirical question for further research.

Our second operationalization of situational importance – making a decision involving oneself versus others – seemed to be unsuccessful: we found no difference in any of the parameters of interest. We believe that this was mainly due to the hypothetical character of our experimental situation. While in real-life situations the difference between taking a decision for oneself or others is easily noticeable, it is not so in hypothetical situations. In the latter situations subjects may not be able to clearly distinguish between taking their perspective and the perspective of an advisor. Thus, we suspect that, although they had to take decisions for others, participants collected and processed situational information as if they were taking decisions for themselves. In contrast, the distinction between situations involving threats to life and threats to capital seems to be easily noticed, even in hypothetical situations.

Our hypothesis that more risk-averse people should be more interested in information about the probability of negative events enjoyed only moderate support. This was unsurprising in the light of prior research on risk attitudes which generally shows that measurement of this psychological characteristic is not a trivial task. Previous studies have demonstrated that risk preferences are neither stable across elicitation methods nor in time (Grether & Plott, 1979; Wärneryd, 1996; Anderson & Mellor, 2009). Therefore in retrospect it was probably unreasonable to expect high correlations between different measures of risk aversion and other variables.

Finally, the hypothesis that more risk-averse individuals should be more interested in information about RDOs went unsupported. In fact, the results were in a contrary direction. Perhaps, issues surrounding the relationship between risk attitude and information search involving RDOs are more complicated than we initially thought.

On the one hand, people who are more risk averse may indeed be more interested in reducing the risk inherent in a situation by applying various RDOs, and thus be more active in searching for information on this topic. On the other hand, more risk-averse individuals might immediately opt for the more certain option, and therefore show lesser or no interest in RDOs since they are only relevant to the risky rather than to the certain option. This issue calls for further research.

This paper has presented evidence that in pseudo-naturalistic scenarios involving natural disasters people tend to actively search for information about probabilities. However, the question arises as to whether people are able to make reasonable use of such information. Here, Baker (1995) tested whether residents of endangered areas use probability information when making evacuation decisions during a hurricane threat and concluded that people were capable of comprehending and using probability information. Similarly, Tyszka and Zaleskiewicz (2006) demonstrated that although subjects had little interest in obtaining information about probabilities in naturalistic risky decision environments, when supplied with such information they were sensitive to it.

Generally, the answer to the question of how well people comprehend and use probability information in dealing with environmental hazards is rather complicated. To understand people's responses to environmental hazards and disasters, Lindell and Perry (2012) proposed the Protective Action Decision Model (PADM). Threat perception plays the main role in this multistage model, in which environmental threats are perceived in terms of an individual's expectations of personal impacts emanating from the environment (such as death, injury, property damage, etc.). The probabilities and severity of these impacts are significant predictors of protective actions taken and evacuation decisions. Research by Baker (1991) and meta-analysis of hurricane evacuation studies by Huang *et al.* (2015) strongly support this claim. The question of how people handle probability information in dealing with environmental hazards requires much future study, but in the meantime it is important to note that responses to hypothetical survey scenarios provide good estimates of actual behavior during hurricane threats (Huang *et al.* 2015). Such findings also suggest that our results could serve as an estimate of the type of information that people would search for in real-life natural disasters.

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APPENDICES

Appendix A: Experimental scenarios

Life-self

You live in a spacious house with a garden. You simply love your house. However, the house is located on a hillside where, in the past, mudslides occurred. Recently, rainfall increased and the occurrence of mudslides grew. Sometimes the mudslides occurred at night and some people were killed. With concerns about residents' safety, local authorities offer people living in the affected area relocation. In return, they offer those homeowners who agree to relocate another house free of charge in a new neighborhood; yet this house is a little less attractive. So you have a choice: either to **stay in your old house**, or to **move to the new house**. By staying in the current house you expose yourself to the mudslides, as a result of which you may die.

You have to make a decision. You have to make this decision under the assumption that you are single, even if, in fact, you have a family. Before this, however, you can obtain other information, which you need to make the decision.

Now please ask your questions. You can ask as many questions as you want.

House-self

You live in a spacious house with a garden. You simply love your house. However, the house is located on a hillside where, in the past, mudslides occurred. Recently, rainfall increased and the occurrence of mudslides grew. Mudslides move at a speed that allows evacuation of people. Yet houses are completely destroyed. With concerns about residents' safety, local authorities offer people living in the affected area relocation. In return, they offer those homeowners who agree to relocate another house free of charge in a new neighborhood; yet this house is a little less attractive. So you have a choice: either to **stay in your old house**, or to **move to the new house**.

By staying in the current house you expose yourself to the mudslides, as a result of which your house might be destroyed.

You have to make a decision. You have to make this decision under the assumption that you are single, even if, in fact, you have a family. Before this, however, you can obtain other information, which you need to make the decision.

Now please ask your questions. You can ask as many questions as you want.

Life-others

You are a representative of a charity organization taking care of an old couple that has no relatives. The couple lives in a spacious house with a garden. They simply love their house. However, the house is located on a hillside where, in the past, mudslides occurred. Recently, rainfall increased and the occurrence of mudslides grew. Sometimes the mudslides occurred at night and some people were killed. With concerns about residents' safety, local authorities offer people living in the affected area relocation. In return, they offer those homeowners who agree to relocate another house free of charge in a new neighborhood; yet this house is a little less attractive. So the couple has a choice: either **to stay in their old house**, or to **move to the new house**. By staying in the current house they expose themselves to the mudslides, as a result of which they may die. The couple in your care asked for your advice about what they should do.

You have to make a decision. Before this, however, you can obtain other information, which you need to make the decision.

Now please ask your questions. You can ask as many questions as you want.

House-others

You are a representative of a charity organization taking care of an old couple that has no relatives. The couple lives in a spacious house with a garden. They simply love their house. However, the house is located on a hillside where, in the past, mudslides occurred. Recently, rainfall increased and the occurrence of mudslides grew. Mudslides move at a speed that allows evacuation of people. Yet houses are completely destroyed. With concerns about residents' safety, local authorities offer people living in the affected area relocation. In return, they offer those homeowners who agree to relocate another house free of charge in a new neighborhood; yet this house is a little less attractive. So the couple has a choice: either to **stay in their old house**, or to **move to the new house**. By staying in the current house they expose themselves to the mudslides, as a result of which their house might be destroyed. The couple in your care asked for your advice about what they should do.

You have to make a decision. Before this, however, you can obtain other information, which you need to make the decision.

Now please ask your questions. You can ask as many questions as you want.

Appendix B: Virus infection scenario (warm-up task) from Bär and Huber (2008)

On an exotic trip you got infected with a life-threatening viral disease. You have a very high fever and your condition does not allow your transportation to Poland. You have to be treated immediately. There are only two medicine options. Which one should you choose?

Alternative A: The usual medicine to treat this illness is Relox. This medicine cures the disease for sure. Unfortunately, as a side-effect your legs will be paralyzed.

Alternative B: A new medicine Nexin is not yet approved for public use. It cures the disease for sure; however an unusual immune disorder might occur as a side-effect.

Appendix C: Choice list for the Holt and Laury (2002) task

Lottery A	Lottery B
1/10 of 20 PLN, 9/10 of 16 PLN	1/10 of 38.5 PLN, 9/10 of 1 PLN
2/10 of 20 PLN, 8/10 of 16 PLN	2/10 of 38.5 PLN, 8/10 of 1 PLN
3/10 of 20 PLN, 7/10 of 16 PLN	3/10 of 38.5 PLN, 7/10 of 1 PLN
4/10 of 20 PLN, 6/10 of 16 PLN	4/10 of 38.5 PLN, 6/10 of 1 PLN
5/10 of 20 PLN, 5/10 of 16 PLN	5/10 of 38.5 PLN, 5/10 of 1 PLN
6/10 of 20 PLN, 4/10 of 16 PLN	6/10 of 38.5 PLN, 4/10 of 1 PLN
7/10 of 20 PLN, 3/10 of 16 PLN	7/10 of 38.5 PLN, 3/10 of 1 PLN
8/10 of 20 PLN, 2/10 of 16 PLN	8/10 of 38.5 PLN, 2/10 of 1 PLN
9/10 of 20 PLN, 1/10 of 16 PLN	9/10 of 38.5 PLN, 1/10 of 1 PLN
10/10 of 20 PLN	10/10 of 38.5 PLN

Appendix D: Question for general risk taking assessment

Now we ask you to try to assess yourself: On a scale from 0 to 10 do you perceive yourself as a person who is willing to take risks? Where 0 means ‘completely unwilling to take risks’ and 10 ‘completely willing to take risks’.

Completely unwilling to take risks										Completely willing to take risks
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
00	11	12	13	14	15	16	17	18	19	10

Appendix E: Significance of Mann-Whitney *U* statistics (all tests are one-sided)

Category	Self Versus Others
Number of questions	$p = 0.16$
RDOs	$p = 0.22$
Number of questions asked:	
Probability joint	$p = 0.43$
Probability of a mudslide	$p = 0.48$
Probability of loss	$p = 0.49$
Number of people asking at least one probability question	
Probability joint	$p = 0.43$
Probability of a mudslide	$p = 0.35$
Probability of loss	$p = 0.42$

Appendix F: Statistics by gender (means are weighted by the corresponding group sizes)

Category	Female			Male			Diff.	*p* Two-Sided
	M	*SD*	*n*	*M*	*SD*	*n*		
Total questions asked	0.109	0.122	68	0.116	0.102	48	–0.007	0.33
Probability joint	0.014	0.019	68	0.018	0.025	48	–0.004	0.60
Probability of loss	0.005	0.010	68	0.007	0.014	48	–0.001	0.99
Probability of a mudslide	0.009	0.013	68	0.011	0.015	48	–0.002	0.51
RDOs	0.020	0.026	68	0.020	0.025	48	0.000	0.87
Risk aversion $_{\text{Holt and Laury task}}$	5.440	1.670	57	5.310	2.020	45	0.130	0.98

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