Extending the Time Horizon: Elevating Concern for Rare Events by Communicating Losses Over a Longer Period of Time

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Extending the Time Horizon:

Elevating Concern for Rare Events by Communicating Losses Over a Longer Period of Time

Companies and individuals tend to underprepare for rare, catastrophic events because they ignore small probabilities and fail to appreciate how risk accumulates. To address this, we present a novel risk communication strategy: "extending the time horizon," i.e., presenting the cumulative probability of loss across time (e.g., a 26% chance of flood over 30 years instead of 1% per year). Across three experiments in different contexts, we investigated the effectiveness of this intervention on motivating protective action. Extending the time horizon led participants to perceive greater risk and increased the likelihood they would opt for a small, but sure loss over the small possibility of a large loss. This behavior was robust to time and experiencing a loss. We also found that extending the time horizon made participants sensitive to smaller probabilities. Taken together, this simple intervention counters misperceptions of risk people have regarding rare events, and effectively motivates protective behavior.

Keywords: Risk communication; Framing; Risk perception; Uncertainty; Protective action; Cumulative risk; Small probabilities; Rare events

Introduction

In 2010, an explosion on a platform owned by the oil company British Petroleum (BP) caused an underwater oil pipeline to break, leaking 134 million gallons of oil into the Gulf of Mexico, causing at least $8 billion in damage to natural resources.[1] This fiasco caused the BP stock to plummet by over 50 percent resulting in a loss of over $100 billion in value (see Kunreuther & Useem, 2018, pp. 173-175). This type of disaster was not on BP’s radar screen but if it had been, steps could have been taken to prevent the oil spill. One important determinant of the lack of attention given to the potential impact of such a disaster was the underappreciation of how risk accumulates over a long period of exposure. As reported by an independent panel reviewing an earlier refinery explosion of BP’s (Baker et al., 2007, pp. 90-91):

> *The performance system has a decidedly short-term emphasis, with performance contracts typically focused on short-term goals [. . .] Decisions and events impacting process safety or human capability may not have a discernible impact for many years. For example, a decision to reduce spending on inspections, testing, or maintenance may have no apparent negative impact on process safety performance for a lengthy period.*

This tendency to prioritize the short-term is not exclusive to BP. Many companies similarly underprepare for rare, catastrophic events like terrorist attacks and financial insolvency because they focus on the next period (e.g., quarter or year) when determining the likelihood of the event occurring (Garicano & Rayo, 2016). Because the one-period likelihood tends to be very small, decision makers often treat the risk as being below their threshold level of concern.

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[1] Deepwater Horizon Natural Resource Damage Assessment Trustees. (2016). Deepwater Horizon oil spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement. Retrieved from http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan

Companies face pressure to behave myopically, i.e., to prioritize avoiding short-term costs without adequately considering their long-term impacts.

Individuals also are myopic when it comes to long-term exposure to risk. Hurricane Harvey and Irma that made landfall in Texas and Florida, respectively, within a period of one week in September 2017 revealed that many people did not have flood insurance to help them recover from the water damage to their homes and businesses. Some might argue that these individuals and firms chose not to prepare for the rare event because they have a high risk tolerance or risk appetite but this may not be the reason. Previous research provides ample evidence that people struggle to fully understand the risks they face.

In this regard, people often underweight low probabilities, treating them as if they are smaller than they actually are or even ignoring them completely, treating them as below their threshold level of concern (Barron & Erev, 2003; Hertwig, Barron, Weber, & Erev, 2004; Kunreuther et al., 1978; McClelland, Schulze, & Coursey, 1993; Meyer & Kunreuther, 2017; Weber, Shafir, & Blais, 2004). A factor amplifying this effect is that people "narrowly bracket" information and decisions—that is, they consider a single occurrence in isolation or consider only short time periods—rather than considering the repeated nature of the risk (Gneezy & Potters, 1997; Kahneman & Lovallo, 1993; Redelmeier & Tversky, 1992; Thaler, Tversky, Kahneman, & Schwartz, 1997).

By definition, rare catastrophic events have low probabilities of occurrence, so when they are framed narrowly, people underappreciate how these risks can accumulate over time (Slovic et al., 1977; Kunreuther et al 1978). For example, flood risks are normally presented in terms of the annual chance of a disaster, despite the fact that people may live in their houses for more than 20 years. When the time horizon over which the probability is calculated is extended, a practice known as *broad bracketing*, people respond differently for the same decision (Benartzi & Thaler, 1999; Hardin & Looney, 2012; Looney & Hardin, 2009; Redelmeier & Tversky, 1992; Webb & Shu, 2017). Broad bracketing is designed to help people counteract their myopic tendencies by having them consider their long-term exposure to a particular risk. The focus of this paper is a novel form of risk communication—extending the time horizon—that can be described as a type of broad bracketing tailored to help people consider actions to protect themselves against rare, catastrophic events.

The tendency to underweight or ignore small probabilities

People have difficulty understanding and evaluating small probability outcomes, only being able to make consistent decisions about them when given concrete contexts or comparison events (e.g., Kunreuther, Novemsky, & Kahneman, 2001). In some cases, people overweight low probabilities (e.g., Tversky & Fox, 1995), while in other situations individuals underweight these probabilities (e.g., Barron & Erev, 2003). McClelland and colleagues, in assessing willingness-to-pay (WTP) for insurance against a low probability disaster, found that some people were not willing to pay anything for financial protection while others were willing to pay much more than the expected cost of a disaster (McClelland et al., 1993). This implies that the former group underweighted the probability of the event by treating it below their threshold level of concern while the latter group overweighted the probability of its occurrence. Importantly, McClelland et al. did not find this bimodality for events with a higher probability of occurring, suggesting people treat very small probabilities quite differently from moderate probabilities.

In this paper, we are primarily concerned with underweighting because it often leads to under preparing for potential disasters. Generally, low probabilities are underweighted when information about them is gathered through experience (Barron & Erev, 2003; Hertwig et al., 2004; Weber et al., 2004). By definition, if an event has a tiny probability of occurring, a person is unlikely to have ever experienced it, and so she may treat it as if it is much less likely to occur than the data may suggest, a phenomenon known as *sampling bias* (Rakow, Demes, & Newell, 2008). This behavior can be amplified by our limited memory capacity in remembering a subset of information when making decisions (Kareev, 1995; Kareev, Lieberman, & Lev, 1997).

Underweighting low probabilities may explain why people are more likely to protect themselves against high probability-low consequence events than low probability-high consequence events (Browne, Knoller, & Richter, 2015; Shafran, 2011; Slovic et al., 1977) even though expected utility theory predicts the opposite behavior if individuals are risk averse. After interviewing multiple CEOs from Standard & Poor's 500 index, Kunreuther & Useem (2018) found that, "Although those we interviewed contended that they were focusing on worst case scenarios, many had also concluded that they could ignore very low probability events. Extreme threats fell below the firm's threshold of concern" (p. 124).

This phenomenon also is reflected by property owners' decisions on whether to purchase flood insurance. Hurricanes Harvey, Irma and Maria in 2017 left behind over $260 billion in damages, much of which were flood-related, making 2017 the costliest hurricane season on record (MunichRe, 2018; NOAA National Centers for Environmental Information (NCEI), 2018). Yet the national penetration rate for flood insurance in high risk zones (Special Flood Hazard Areas) remains surprisingly low—only 49% of homes in these areas are insured against damage from floods even though most of these individuals are required to purchase coverage as a condition for a federally insured mortgage. In some areas of the country, the purchase rate was as low as 22% (Dixon, Clancy, Seabury, & Overton, 2006).

The tendency to narrowly bracket decisions

The problem of underweighting small probabilities is exacerbated by the fact that decision makers often "narrowly bracket" choices by considering each of them in isolation, rather than considering their aggregate effect over time (Kahneman & Lovallo, 1993). This causes people to make different choices when they are asked about prospects individually compared to when they are asked to consider multiple prospects or multiple time periods (Gneezy & Potters, 1997; Thaler et al., 1997).

However, even though people are more likely to make better choices when asked to consider decisions over time or over multiple prospects, they will often still struggle to make optimal choices because aggregating probabilities is a computationally difficult task (e.g., Redelmeier & Tversky, 1992; Slovic, Fischhoff, & Lichtenstein, 1978). To illustrate, when asking willingness-to-pay (WTP) for protection measures that would last for different lengths of time such as investing in a dead bolt lock to prevent thefts while one was living in an apartment, many people gave the same WTP for protection over one year and protection over five years despite the fact that more benefits accrue if protection is used for five years (Kunreuther, Onculer, & Slovic, 1998). If people narrowly bracket information about rare events, they are unlikely to appreciate the large risk they face over multiple time periods. Without being aware of this large probability of loss, they likely dismiss their risk as negligible, or below their threshold level of concern.

Previous research has found that explicitly providing aggregate probability information over time can be helpful in *encouraging* selection of positive EV risky choices such as investing in stocks rather than bonds (Benartzi & Thaler, 1999; Hardin & Looney, 2012; Looney & Hardin, 2009), and can *discourage* the selection of negative EV risky choices rather than a certain loss (Webb & Shu, 2017). The intervention we propose is a specific type of broad bracketing meant to bring attention to the aggregated probability of loss over multiple periods: extending the time horizon over which loss probabilities are calculated. This involves communicating the probability of at least one loss across the span of multiple periods. This serves not only to encourage long-term thinking, but also to elevate the probability under consideration to a level that captures the decision maker's attention and reduces the likelihood that they ignore the threat.

Experiencing rare events influences decision making

An important aspect of this investigation is examining whether the effect of extending the time horizon is robust to experience. Much of the evidence on the effectiveness of broad bracketing interventions comes from experiments in which choices are clustered, that is, when one decision is applied to a series of choices, which means the time frame of the probability information is matched to the time frame over which the decision applies. For instance, participants given information about 30-year stock and bond returns were making a single decision about how much to invest over 30 years (Benartzi & Thaler, 1999), rather than being asked how much they want to invest annually over a 30-year period.

For many decisions, like budget allocations at a company or insurance purchase decisions, choices must be made repeatedly with decision-makers receiving feedback about such choices during each time period, such as whether a company division is experiencing losses or whether there was a flood. This feedback has a substantial impact on future choices because it affects beliefs about probabilities in a different way than simply knowing the numerical value of the probability (Barron & Erev, 2003; Barron & Ursino, 2013; Barron & Yechiam, 2009; Camilleri & Newell, 2011; Hertwig et al., 2004; Rakow et al., 2008).

More generally, myopia leads people to forget about the long-term trends and to overweight recent feedback/experience. For instance, just prior to the 1989 Loma Prieta earthquake in California, only 22% of homeowners in the Bay Area had earthquake coverage. Four years later, 36.6% of residents had purchased earthquake insurance—a 63% increase in coverage (Palm, 1995, p. 62). This shows that demand for insurance tends to increase following a disaster.

The fact that people tend to pay more attention to their most recent experiences leads people to exhibit what is called a “recency effect” (Barron & Yechiam, 2009; Hertwig et al., 2004; Hogarth & Einhorn, 1992). This behavior is triggered by the availability bias in the sense that there will be a tendency to overestimate the likelihood of a future disaster when the event is salient in one’s mind (Tversky & Kahneman, 1973), but this also means that if they have not observed the event recently, they are likely to underestimate its likelihood. This is problematic for low probability, high consequence events because, by definition, people rarely experience rare events. As a result, people underweight small probabilities until they experience a disaster, which may partially explain why people underprepare for potential hazards (Barron & Erev, 2003; Barron & Ursino, 2013; Barron & Yechiam, 2009; Camilleri & Newell, 2011; Hertwig et al., 2004; Meyer & Kunreuther, 2017; Rakow et al., 2008; Weber et al., 2004).

There is also reason to believe that the opposite behavior from these predictions may occur. In some cases, people have been shown to exhibit a *negative* recency effect, or what is known as “the gambler’s fallacy” (Jarvik, 1951; Kahneman & Tversky, 1972). For instance, if a roulette wheel, which has an equal chance of landing on black or red, turns up black five times in a row, people often think (incorrectly) that, on the next spin, red is more likely to occur. If this behavior characterizes people's views of the likelihood of future disasters occurring, then these individuals would be less likely to engage in protective actions following a flood or earthquake.

When it comes to rare events, there is evidence that people exhibit both types of judgments in their decisions following an experience (Croson & Sundali, 2005; Plonsky, Teodorescu, & Erev, 2015; Yin, Chen, Kunreuther, & Michel-kerjan, 2017). As a result, we expect that experience will significantly impact participants' decisions and probability assessments. We examine whether the effect of extending the time horizon is robust to past experience regardless of whether individuals exhibit the recency effect or gambler's fallacy as highlighted by our first hypothesis (H1):

> ***The effect of extending the time horizon (Hypothesis 1).*** Extending the time horizon used to express the probability of experiencing at least one loss from a given event increases the likelihood that participants will choose to avoid that risk in each period by incurring a certain, but smaller loss.

In the following two studies, we examine whether extending the time horizon for expressing the probability of rare negative events is effective at driving people to choose the safe over the risky option when asked to make repeated single-period decisions and whether the effect is stronger than the effect of past experience. These experiments, one in an abstract context (Experiment 1) and the other in a flood insurance context (Experiment 2), are meant to mimic the essential decision structure of real-world contexts in which protective behavior is relevant. They are designed to test a potential risk communication strategy to help encourage people engage in protective behavior. In Experiment 3, we examine whether this risk communication strategy could cause people to behave in an overly risk averse way and to choose the safe option even when it is excessively costly. Finally, we discuss the practical implications of our findings as well as future directions.

Experiment 1: Certain Loss vs. Loss Lottery

Experiment 1 examined extending the time horizon in an abstract context in which participants selected between two options: a small certain loss or a gamble with a small probability of a large loss and large probability of no loss or gain. To examine the impact of experience and the repeated nature of the decision, individuals make this choice for 15 rounds, with a third of the participants never observing a negative loss from the gamble, one third witnessing it early in round 4, and the other third witnessing it late in round 11. Our pre-registered design and hypotheses can be found at https://aspredicted.org/yy24t.pdf.

Methods

Participants and procedure

Participants were recruited from Amazon's Mechanical Turk (MTurk) online platform to complete a 10 minute study for $0.50 plus a bonus. During each round, each individual was given $95 and had to select between two options: (1) a certain loss of $0.45 ("certain loss") or (2) a lottery with a chance of losing $45 ("loss lottery"). We varied the probability frame participants saw about the chances of losing money in the loss lottery. Everyone knew they would make this decision multiple times, but they did not know exactly how many rounds, only that it would be less than 25. We did this to avoid different behavior in the last round of the experiment (i.e., round 15). After each round, everyone was given feedback about whether or not the lottery resulted in a loss, regardless of which option they had chosen. At the beginning of each round, the $95 was restored to the initial level so that the financial impact of decisions in previous rounds would have no impact on their decision in the current round. The exact wording of the scenario can be found in the online supplement. (See Appendix D for a link to the online supplement and a list of its contents.)

Conditions

The experimental design was a 2 (time horizon: 1-play, 30-play) x 3 (loss occurrence: none, early, late) between-subjects so that participants were randomly assigned to one of six conditions. Participants were given probability information on either the 1-play likelihood of a loss occurring from selecting the lottery (1%) or the 30-play likelihood of at least one loss occurring (26%). One third of the participants learned that a loss occurred in round 4 (early-loss group), one third learned about a loss in round 11 (late-loss group), and the other third did not observe any losses from the lottery (no-loss group).

Measures

After reading the initial instructions, but before beginning the first round of the experiment, participants had to correctly answer three comprehension check questions (see the online supplement for more detail). The perceived likelihood of a loss occurring in the next round was assessed after rounds 1, 4, 11, and 15. We only asked this question four times to reduce decision fatigue. We chose rounds 1 and 15 to assess participants' initial beliefs without experience and their final beliefs. We included rounds 4 and 11 to examine the immediate effect of witnessing a loss on participants' beliefs. The question was asked after participants learned the loss outcome for that round and was posed as follows: "How likely do you feel it is that the lottery next period will result in a loss?" [sliding scale: 0 = extremely unlikely to 10 = extremely likely].

We assessed risk preferences using two measures: one self-reported and one choice-based. The self-reported measure was as follows: "How do you see yourself: Are you generally a person who likes to take risks or do you try to avoid taking risks?" [sliding scale: 0 = not at all willing to take risks to 10 = very willing to take risks] (Dohmen et al., 2011). The choice-based measure was adapted from Gneezy & Potters (1997): We endowed participants with $0.50 and gave them an opportunity to invest in an option with a 50% chance of succeeding and a 50% chance of failing. If the option succeeded, they would receive 2.5 times the amount they invested, but if it failed, they would lose the amount they invested. Participants had to decide how much of the 50 cents they wanted to invest in the option (in 1-cent increments). At the end of the experiment, participants were told whether the option succeeded or failed and how much money they earned from their decision on that task. Participants also answered questions about their age, gender, income, education, employment status, and political identity.

Payment

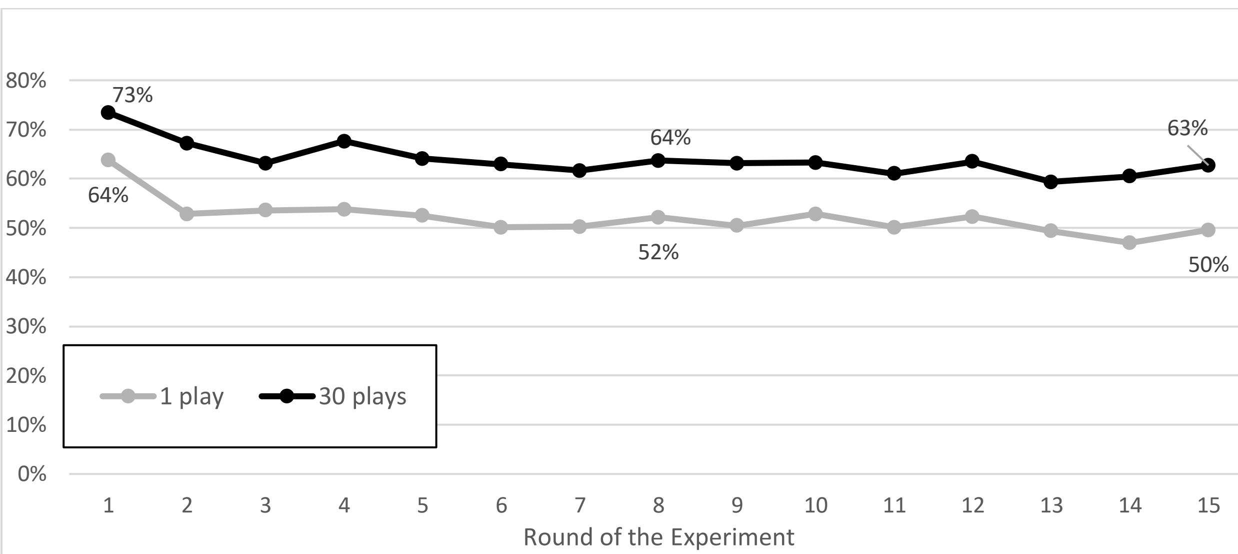
All participants earned $0.50 for completing the survey. Choices were incentivized with real money: One in every 100 participants was paid for their decisions via a random process that involved a future outcome of the Florida State Lottery's Pick-2 game (http://www.flalottery.com/pick2). For every 100 participants, each participant was randomly assigned a number between 0 and 99, which was displayed on the screen at the beginning and end of the experiment. They were given a specific future date and time of the Florida Pick-2 Lottery and told that if their number was chosen at that time they would be paid based on their decisions from a random round of the experiment. The number of the random round was displayed on the screen at the end of the experiment.[2] See the online supplement for information about how much participants were paid.

Results

The extended time horizon effect on repeated choices and subjective likelihood

The final analyzed sample contained 1,076 participants (56% female, M_{age} = 36 years). Information on dropout rate and rate of comprehension check failure can be found in the online supplement. As shown in Figure 1 and captured in regressions described below, results strongly support H1, the effect of extending the time horizon: Those who were given a probability frame based on 30 plays of the gamble were more likely to choose the certain loss (the safe option) than those who were provided with a one-play probability, an effect that did not change across the 15 rounds, as confirmed through a panel regression that we now describe.

Figure 1. Proportion of participants selecting the certain loss in each round



[2] A procedure similar to this was used as a way of paying participants large sums of money in a related online experiment involving choosing between a safe option and a risky one. For more details see Kunreuther and Michel-Kerjan (2015).

To explicitly test the hypotheses about extending the time horizon and experience of loss we regressed individual choices over all 15 rounds of the experiment on treatment assignment (1-play vs. 30-play probability framing and early- vs. late- vs. no-loss occurrence), round effects, and treatment group and round interactions. The panel regression model is specified as:

$$(1)\ CLchoice_{ij} = \alpha + \beta_0 j + \pi_0 30play_i + \pi_1 30play_i \times j + \pi_2 30play_i \times post_{ij} + \gamma_0 post_{ij} + \gamma_1 post_{ij} \times k_{ij} + \gamma_2 post_{ij} \times late_i + \gamma_3 post_{ij} \times late_i \times k_{ij} + \mu_{ij},$$

where $CLchoice_{ij}$ is the choice of individual *i* in round *j* of either the certain loss ($CLchoice_{ij} = 1$) or the lottery ($CLchoice_{ij} = 0$), $30play_i$ indicates assignment of individual *i* to either the short ($30play_i = 0$) or extended ($30play_i = 1$) time horizon treatment group, $post_{ij}$ indicates rounds *j* following the experience of a loss in round *j-1*, $late_i$ indicates assignment of individual *i* to the late-loss experience group, and k_{ij} indicates the number of rounds that have occurred since the experience of loss to individual *i* in round *j*. In addition to treatment group, round effects, and interaction effects, we also control for demographic and other self-reported individual characteristics.

Equation (1) estimates are presented in Table 1 using a random-effects linear panel regression with heteroscedasticity-consistent standard errors (MacKinnon & White, 1985).[3] Participants with the short time horizon group (the baseline group, represented by the constant

[3] In the estimates that follow, the variance-covariance matrix of the estimates is modified to account for heteroscedasticity under general conditions with a degrees-of-freedom correction (referred to as the HC1 method, MacKinnon and White 1985). In this case, because the number of respondents and observations is relatively large, using HC1 standard errors (instead of the random-effects least-squares standard errors) and the choice of HC1 modification does not have a noticeable effect on inference and the qualitative results.

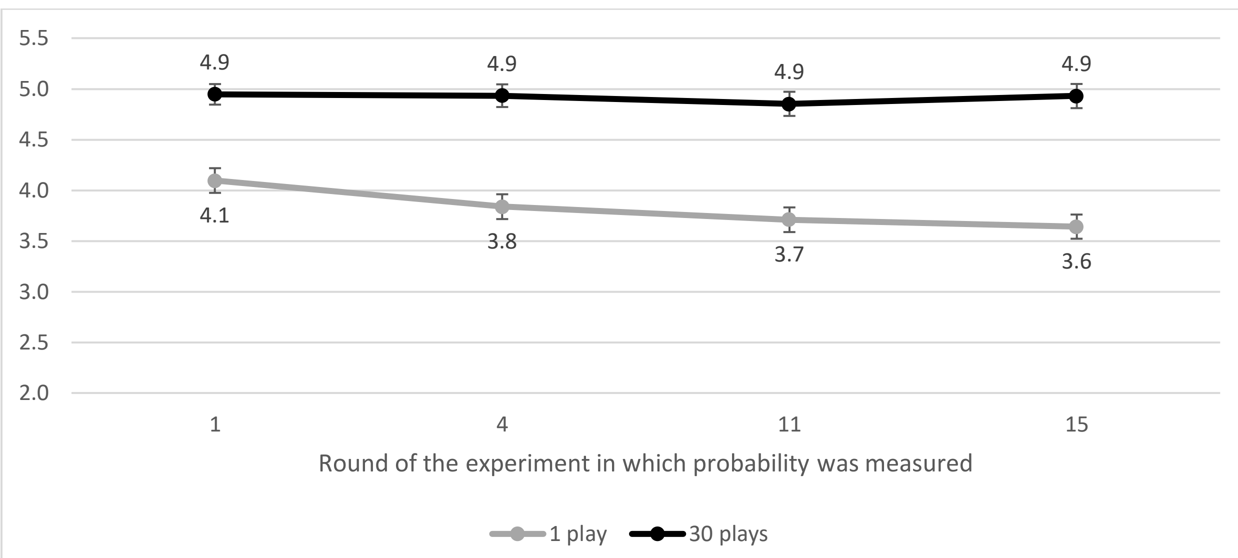
term in the regression) had a 58.4% likelihood of choosing a certain loss in period 1 while those who saw the 30-play probability frame ("30-play probability" which represents the π_0 parameter) were 11.5 percentage points more likely to select the certain loss (i.e., to avoid the lottery) in a given round, a difference that is statistically significant at the $p < 0.001$ level. This effect did not change across the course of the 15 rounds of the experiment: Parameter estimates of the interaction between round and the 30-play frame ("30-play prob. x round") and rounds following a loss ("30-play prob. x time since") are not distinguishable from zero, with or without the inclusion of demographic and other controls. These findings provide strong support for H1.

Importantly, witnessing a loss did not affect the impact of the 30-play frame on decisions in the short term. This is captured in Table 2, which displays regression results for choices only in rounds 5 and 12, i.e., the rounds immediately following a loss for one of the three loss groups. The coefficients for the interaction terms "30-play prob. x early" in round 5 and "30-play prob. x late" in round 12 are not significant. Thus, the likelihood of selecting the certain loss in rounds 5 and 12 was higher for people in the 30-play frame regardless whether a loss occurred or not in the previous round. Time also did not reduce the impact of the 30-play frame regardless of whether participants witnessed a loss or not. This is true for the immediate period following a loss (Table 2: "30-play prob. x early" in round 5 and "30-play prob. x late" in round 12), and also for the delayed impact of experience (Table 1: "30-play prob. x round"; "30-play prob. x time since").

The decisions above are reflected in beliefs about subjective probability of the negative event occurring in the next period: Participants' subjective assessment of the likelihood of loss in the following round was consistently higher on average for those who saw the extended time horizon (30-period) probability rather than the short time horizon (single period) probability. We formally estimated the effect of the time horizon assignment on perceived probability with a random-effects panel regression model and the difference between the short and extended time horizon groups was statistically significant at $p < 0.001$ (See Table A.1, Appendix A).

Through the regressions in Table A.1, we know that participants who saw the 30-play probability of a loss thought that the likelihood of a loss was higher on average by 0.9 points and this difference did not change significantly across the four rounds where this question was asked (Table A.1, "30-play probability," "30-play prob. x round 4," "30-play prob. x round 11," and "30-play prob. x round 15"). As depicted in Figure 2, participants who saw the 1-play time frame indicated, on an 11-point scale (0 = extremely unlikely to 10 = extremely likely), that they believed a negative event occurring in the next round was relatively unlikely, with an average rating of 4.1 in round 1 and 3.6 by round 15 compared to a stable 4.9 for the 30-period time frame.

Figure 2. Average subjective likelihood that the lottery would result in a loss in the next round.



Note: Standard errors shown

Subjective assessments may be a mediator of the effect of extending the time horizon on the choice of certain loss. We conducted a mediation analysis where the 30-play effect was mediated by subjective assessments reported by participants in the previous round. (This was performed using the R package "mediate." See the following for details: Imai, Keele, & Tingley, 2010; R Development Core Team, 2009; Tingley, Yamamoto, Hirose, Keele, & Imai, 2014). This indicated that the observed 30-play effect was due in part to extending the time horizon's increasing subjective assessments, which then increased the likelihood of choosing a certain loss (Table A.3). Results indicate that between about 10% and 52% of the extended time horizon's effect on the choice of certain loss was mediated through increased assessments of the likelihood of loss (see "proportion mediated" in Table A.3).

Summary and Discussion

In Experiment 1, we found that extending the time horizon for expressing the probability of a loss increased the likelihood that a participant would prefer the safe option in a choice between a lottery with a chance to lose a large amount of money and smaller but certain loss. This effect remained consistent across multiple rounds in which participants had to make the same decision repeatedly. That is, there did not appear to be any learning, and the difference in the proportion of people choosing the certain loss between the 30-play and the 1-play probability frame conditions did not change across the 15 rounds. Lastly, this gap persisted regardless of whether or not participants witnessed or suffered a loss.

Experiment 2: The Context of Flood Insurance

Recent research suggests that participants exhibit different behavior when choices are framed neutrally rather than in a particular context (see Jaspersen, 2016 for a review). For example, participants show more risk aversion when making decisions about insurance than when making context-free decisions for the same risk (Hershey & Schoemaker, 1980; Lypny, 1993). Experiment 2 was designed to determine the impact of extending the time horizon in the context of flood insurance for the following two reasons: First, it is a decision made by consumers rather than managers, so it would be easier for participants to imagine this context and, secondly, it has policy relevance since few homeowners in flood prone areas purchase flood insurance today.

Given the major hurricanes and floods in recent years, this intervention could be extremely useful in convincing individuals to protect themselves financially against this risk. For this reason, we added relevant features to this experiment that might be faced by a homeowner when making this decision: We investigated an additional hypothesis related to the communication of flood risk: the identification of a home as being within a high-risk area designated by the Federal Emergency Management Agency (FEMA) as a Special Flood Hazard Area (SFHA). Flood insurance is required for homes located in one of these SFHAs that are financed with a federally insured mortgage, but we did not tell the participants that this was the case so they could make their choice on whether or not to insure without this background information. We examine whether this distinction affects risk perception and the decision of whether or not to purchase flood insurance as indicated by the following hypothesis (H2):

> ***Special flood hazard designation (Hypothesis 2).*** Identification of a homeowner's location within a Special Flood Hazard zone will increase their perception of the flood risk, thereby increasing the likelihood that participants will purchase and retain flood insurance.

Our pre-registered design and hypotheses can be found at https://aspredicted.org/zk86a.pdf.

Methods

Participants and procedure

Participants were recruited from MTurk to complete a 10 minute study for $0.50 plus a bonus and were paid on average $1.09 (range: $0.51-$1.75). The procedures for this experiment were identical to that of Experiment 1, except that the scenario now incorporated a flood insurance context. So people would consider larger numeric amounts as would be the case in the flood insurance context, we used an artificial currency called "talers" with an exchange rate of 1,000 talers = $1.00. We also included comprehension check questions, assessment of risk preferences, and four subjective probability assessments, as in Experiment 1. For the exact wording of the scenario and additional measures, see the online supplement.

Conditions

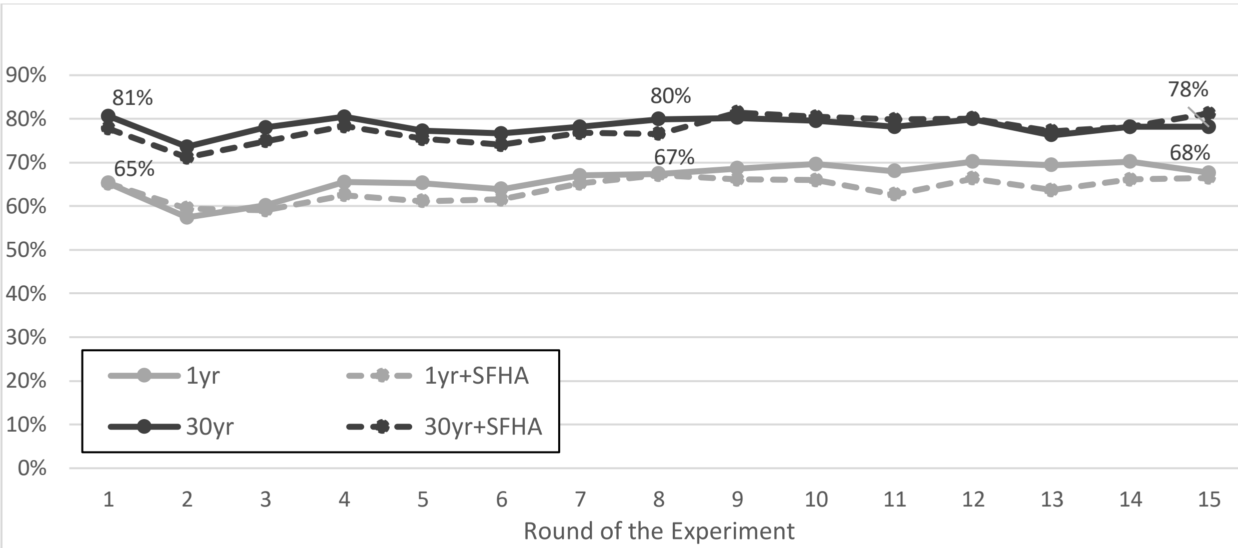
To test H2, we included an additional variable so that the experiment was a 2 (time horizon: 1-year, 30-year) x 3 (flood occurrence: none, early, late) x 2 (presence of SFHA designation: yes, no) between-subjects design. Participants were thus randomly assigned to one of twelve conditions.

Results

The extended time horizon effect on repeated insurance uptake and subjective likelihood

The final sample analyzed contained 2,076 participants (45% female, M_{age} = 35.9 years). Information on dropout rates and rate of comprehension check failure can be found in the online supplement. The purchase rate of flood insurance was on average 15 percentage points higher for participants who saw the extended time horizon (i.e., likelihood of experiencing at least one flood over a 30-year time horizon) compared with those who saw the short time horizon (i.e., 1-year flood probability time horizon) as shown in Figure 3. The likelihood of purchasing insurance in the extended time horizon group did not change across the 15 rounds of the experiment, while the likelihood slightly increased over time among those in the short time horizon group, resulting in a smaller gap between the two groups by the end of the experiment.

Figure 3. Proportion of participants purchasing flood insurance in each round



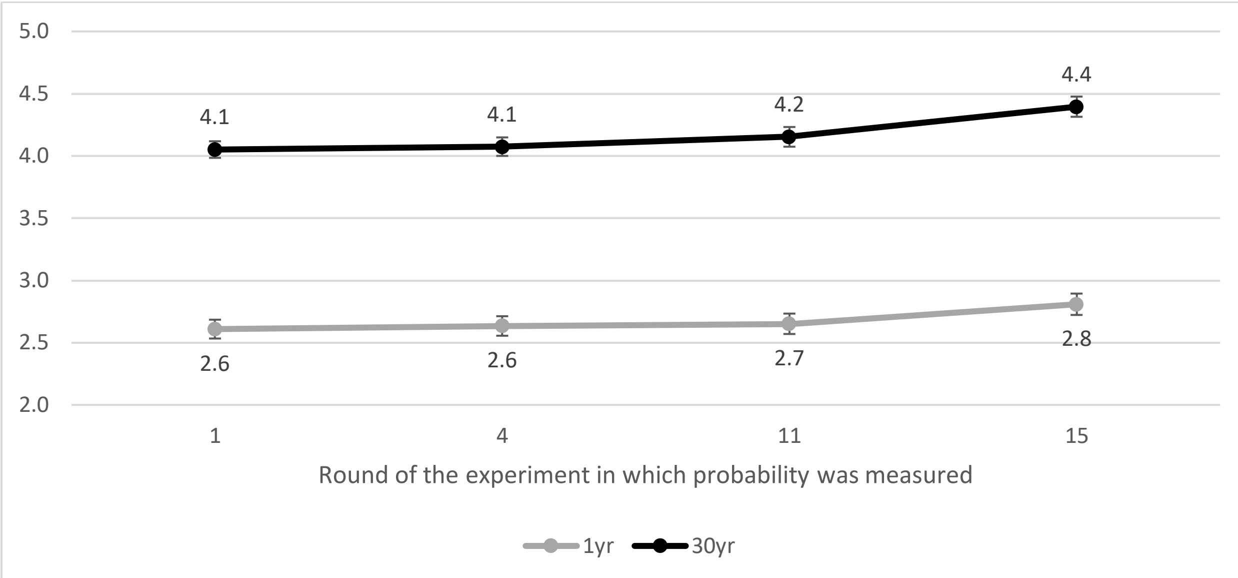
We tested H1 by running a random-effects linear panel regression with heteroscedasticity-consistent standard errors. We describe the details of this pre-registered model in Appendix B and the results are presented in Table B.1. However, because we found no impact of identification within the Special Flood Hazard Area (i.e., H2 was not supported), we collapsed our treatment variables and ran a regression similar to the one in Experiment 1 (Table 3). In this way, we can more easily compare the results from the two experiments.

As summarized in Table 3, participants with the short time horizon had a 61.7% likelihood of purchasing insurance. Relative to that group, participants with the extended time horizon were 15.1 percentage points more likely to purchase flood insurance in a given round, a difference that was statistically significant at $p < 0.001$.

Similar to Experiment 1, the extended time horizon manipulation is robust to the effects of experiencing a loss from a flood: Table 4, displaying regression results for choices in only rounds 5 and 12, shows that the proportion insuring in these rounds among those who saw the 30-year probability is higher than those who saw the 1-year probability ("30-year probability in Table 4) and this is unaffected by experiencing a flood in the previous round ("30-year prob. x flood round 4" for Round 5, "30-year prob. x flood round 11" for Round 12 in Table 4). Among those who did not experience a flood, the overall insurance uptake rate among those with the short time horizon increased over the 15 rounds by 0.3 percentage points per round ("Round" in Table 3), but this change was not present for those who saw the extended time horizon—their purchase rate did not change across the 15 rounds ("30-year x round" in Table 3). Among those who did experience a flood, the round effect was not different across the two time horizons(Table 3, "30-year prob. x time since"). The slight differences in results between Experiments 1 and 2 will be addressed in the general discussion.

As in Experiment 1, the effect of extending the time horizon on insurance purchases appears to be related to differences in participants' subjective assessment of the likelihood that a flood occurs in the next round (elicited after round 1, 4, 11, and 15) as shown in Figure 4. According to a random-effects panel regression of subjective assessments (Table B.2), participants exposed to the extended time horizon consistently had average ratings of flood likelihood about 1.45 points higher (on a scale where 0 = extremely unlikely to 10 = extremely likely) than those exposed to the short time horizon.

Figure 4. Average subjective likelihood that a flood would occur in the next round



Note: Standard errors shown

A mediation analysis was also conducted in Experiment 2, with subjective assessments serving as a mediator between the effect of 30-year probability framing and insurance purchase decisions. The analysis, detailed in Table B.3, indicated that the extended time horizon effect was partially or completely mediated by increases in subjective assessments, which then increased the likelihood of purchasing insurance. As shown by the "proportion mediated" measure in Table B.3, between about 69% and 100% of the broad-bracketing effect on the purchase of insurance was mediated through increased assessments of the likelihood of loss.[4]

Summary and Discussion

Similar to the results from Experiment 1, we found in Experiment 2 that extending the time horizon over which probabilities are calculated increases the probability that participants

[4] For rounds 5 and 12, the mediated effect is large enough to offset a direct effect in the opposite direction, and so the "proportion mediated" appears to be slightly above 100%. Given that the direct effect is not different from zero, this is simply taken to mean that the mediator (subjective assessments of likelihood) fully accounts for the observed effect (choice) in these rounds.

choose to avoid risk, which, in this case, meant purchasing flood insurance and incurring a certain loss by paying a premium before one knew whether or not a flood would occur. Furthermore, the extended time horizon effect was robust across specifications, across rounds, across time, and witnessing a flood loss whether or not one had purchased insurance.

Experiment 3: The Impact on Preferences

Extending the time horizon could make people overly worried about the risks so that they are willing to spend excessively to protect themselves against a potential loss. In this experiment, we used a metric to determine whether extending the time horizon makes people “too” risk averse. Kunreuther et al. (1978) characterized the contingency price ratio (R) as the expected cost-benefit ratio of protecting oneself against a probabilistic negative event. The equation for this ratio can be found in Appendix C. The larger the cost of protection and the smaller the probability of the negative event occurring, the larger R becomes. Risk averse utility maximizers should be willing to undertake any action with $R \leq 1$. As R increases an individual has to be more risk averse to want to undertake protective action such as choosing a safe option rather than playing a lottery, *if they are maximizing expected utility*. Undertaking protective actions with $R > 10$ implies either excessive risk aversion if they are maximizing expected utility or using an alternative strategy for choosing between the above two options. Here we present participants with a menu of choices with different values for R and determine if and to what degree extending the time horizon makes people behave as if they have excessive risk aversion and were maximizing their expected utility by choosing the safe option.

Method

Procedure

Participants were recruited from MTurk to complete a 10 minute study for $1.00 plus the chance to win a bonus. Participants were presented with two menus of ten incentivized decisions, and for each menu, they were endowed with a certain number of points (1000 points = $1.00). For each of the ten decisions, participants chose between a certain loss (either 500 or 4,000 points) and a lottery with a small chance of losing a larger amount (either 10,000 or 80,000 points). Decisions varied only in the probability of loss in the lottery, which resulted in different values of R. Table 5 describes the probabilities associated with each decision for both the short and extended time horizons. The loss probabilities varied from 0.1% (Decision 1) to 5% Decision 10). The certain loss was equal to the expected value of the lottery with a 5% chance of loss. Hence the expected value of all lotteries with a probability of loss less than 5% was higher (i.e., less negative) than the certain loss and, choosing the certain loss implied risk aversion for all decisions except Decision 10. Each decision was designed to detect a different level of risk aversion for those who chose the certain loss. The value of R for each decision is displayed in Table 5 next to the corresponding probability. A risk aversion level that leads to a ratio of greater than ten is considered be excessive. Following the two menus, participants completed the Gneezy-Potters risk aversion measure and demographics as before.

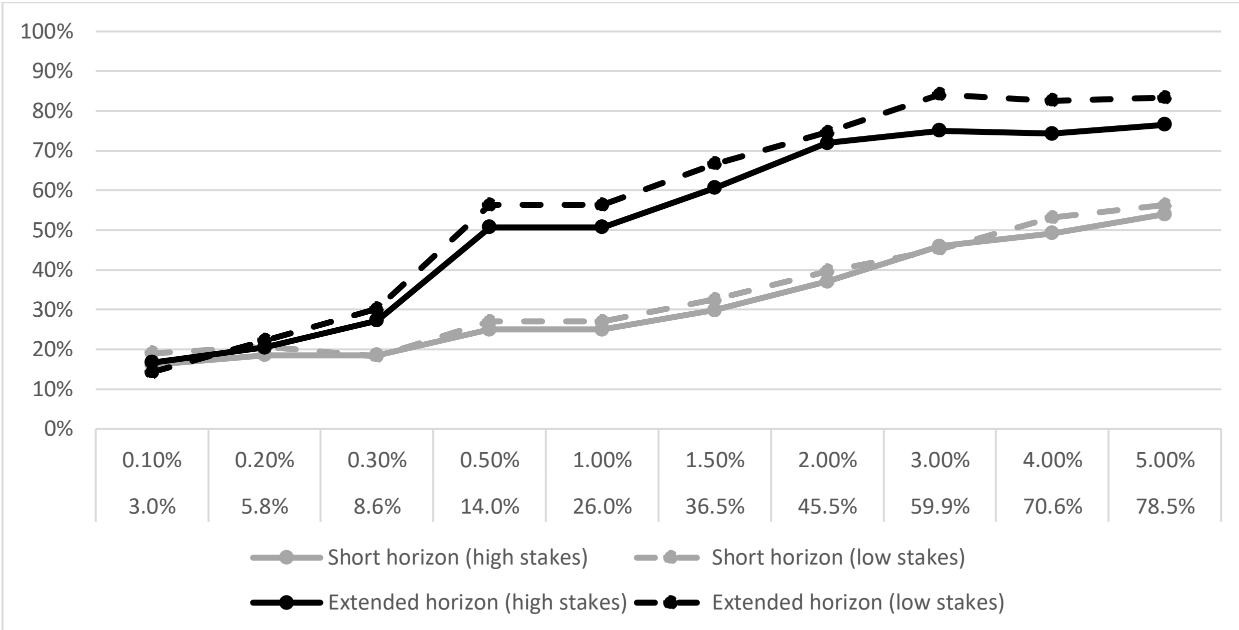
Conditions

The design was 2 (time horizon: 1 play, 30 plays) x 2 (magnitude of loss: low, high). For the first set of choices, people were randomly assigned to either learn the one-time probability of losing each lottery (short time horizon), or learn the probability of losing each lottery if they were to play it 30 times (extended time horizon). They were also randomly assigned to choices that involved losing either a small amount (10,000 points) or a large amount (80,000 points). For the second menu, participants made decisions in the context of the other time horizon and other loss magnitude. Thus, each participant experienced two of the four conditions.

Results

We collected 508 participants (47% female, 35.7 years), with 124-132 per condition. Because we found that choices in the second menu were influenced by information seen in the first menu—it magnified the effect of extending the time horizon—we analyzed only choices made for the first menu, making all analyses between-subjects. For an analysis of order effects and the extent to which they amplified the effect of extending the time horizon, see the online supplement. Regression results are summarized in Table 6 and visualized in Figure 5. As can be seen in the regression, the size of the stakes did not have any impact on the choice of the certain loss or lottery. As one would expect, given that R decreases as the probability of loss increases with the decision number, more people chose the safe option as a function of the decision number by about 4.6-5.7 percentage points ("Decision Number"), depending on the regression specification. These decisions are consistent with expected utility maximization behavior but do not necessarily imply that individuals are actually using this model in making their choices.

Figure 5. Proportion who chose the certain loss for each of the 10 decisions (N = 508)



Note: The X-axis indicates the probabilities shown in the short (top) and extended (bottom) time horizon conditions for Decisions 1 through 10 (left to right).

Examining decisions as separate indicator variables rather than a continuous measure (see Table C.1 in Appendix C), we found that, for people with the short time horizon, the first two increases in probability (Decisions 2 and 3) did not cause a change in the proportion of people selecting the safe option. This is suggestive of a "threshold level of concern," that is, that events with probabilities below a certain level (in this case, 0.5%) are ignored and so are changes in their probabilities that also remain below the threshold. This proposal of a threshold level of concern is further supported by the fact that risk aversion did not result in different behavior until Decision 4 (see Table C.1, "Decision 2-10 x Risk Aversion").

When breaking people up based on quartiles of risk aversion—i.e., 25% of people in each of four categories of risk aversion from lowest to highest—we find that even people with the highest level of risk aversion do not behave differently from the people with the least amount of risk aversion until Decision 4 (see Table C.3, "Low/Med/High Risk Av x Decision 2-10"). The fact that higher risk aversion did not lead people to behave differently for Decisions 1-3 is in line with the evidence that people tend to dismiss events with probabilities of 0.3% or lower.

We found no effect of the extended time horizon for the first two decisions where the likelihood of a loss was extraordinarily small (i.e. 1 in 1000 and 1 in 500) and over 75% of the individuals decided to play the lottery, which, again suggests that the chance of a loss was below their threshold level of concern (see Table C.1, "Extended time horizon" and "Extended x Decision 2-10"). As the probability of a loss increased, the extended time horizon increased the likelihood of choosing the safe option by an average of 3.4-3.6 percentage points for each successive decision relative to the baseline effect in the short time horizon condition (Table 6, "Extended x Decision Number"). Extending the time horizon of probabilities for a given set of events led people to be more sensitive to changes in probability than when they were presented with the one-period probabilities. Risk aversion did not interact with the impact of the extended frame (Table 6, "Extended x Risk Aversion"), meaning the intervention affected people of all risk aversion levels to the same degree.

Most people were unwilling to pay to avoid the risky option when doing so would mean that, if they were indeed maximizing their expected utility, they would be excessively risk averse ($R > 10$) (i.e., Decisions 1-4). Under the short time horizon, fewer than 30% of people opted for the safe option in these decisions.[5] The extended time horizon did not change this for Decisions 1 and 2, with loss probabilities less than 0.3%, but it did raise the proportion of people selecting the safe option for Decisions 3 and 4 by 12 and 20 percentage points, respectively, relative to the short time horizon. The effect of the extended frame was even larger for decisions with $R \leq 10$

[5] Kunreuther et al. (1978) found that about 15% of the people in their sample behaved this way.

(26-36 percentage points), that is, decisions for which the cost-to-benefit tradeoff of avoiding the lottery was much lower.

Discussion

As the loss probability associated with a lottery increased, so too did the tendency to select the safe option, consistent with the fact that the expected cost-benefit ratio (R) was lower. The extended frame amplified this effect, leading more people to prefer the safe option when the probability of a loss was low, except for the two smallest probabilities when less then 20 percent of participants chose the safe option. Risk aversion did not interact with the extended frame, meaning people with both high and low levels of risk aversion were more risk averse when presented with probabilities implied by the extended time frame. The extended frame seemed to lower the threshold of concern such that the percentage of people preferring the safe option increased when loss probability was increased to 0.3%, whereas with the short time horizon frame, behavior was not affected until the loss probability was at least 0.5%.

It should be noted that this choice behavior also means that the extended time frame caused some people to select the safe option when it was excessively costly (i.e., $R > 10$). However, the proportion of people switching to the safe option when $R > 10$ was always smaller than the proportion of people switching to the safe option when $R \leq 10$, that is, when it was more "reasonable" to do so to avoid the lottery. Even so, using an extended time frame to incentivize individuals to take protective action may have a positive impact on social welfare given the negative externalities that arise from failing to undertake protective action. We discuss this further in the general discussion.

General Discussion

Individuals often underprepare for rare, but potentially disastrous events because they underweight or completely ignore small probabilities when decisions are framed narrowly. We proposed and tested a novel risk communication strategy, *extending the time horizon,* specifically tailored to address this problem by presenting participants with the choice between a safe option (small loss) and a risky option with a probability of a much larger loss. Participants either saw the probability calculated with a short time horizon (one-period probability of a loss) or an extended time horizon (30-period probability of a loss). Participants were required to make their choice repeatedly, i.e., in each of 15 periods, which is reflective of many real world decisions such as investing in stocks and purchasing insurance.

When individuals were given information with the extended time horizon, they were much more likely to select the safe option. The extended time horizon also increased their perceived probability of a loss in the following period whether or not there was a loss. Importantly, the effect of extending the time horizon was consistent across all 15 periods and was robust to the experience of a rare loss. These results imply that this communication strategy could be effective at preventing organizations and individuals from ignoring the possibility of rare catastrophic events, and thus help them become more resilient in the future. These findings also point to future work examining the effectiveness of this communication strategy in a field context, such as purchasing flood insurance in hazard-prone areas subject to water-related damage.

Context differences

While the main results (i.e., for H1) across Experiments 1 and 2 are the same, there are some notable differences attributable to context that are summarized in Table 7. Consider those people who were given the short time horizon (1-period probability). Though the baseline proportion of people selecting the safe option was similar in the abstract (58.4%) and flood insurance (61.8%) contexts, the baseline probability *decreased* for each additional round by 1.1 percentage points in the abstract context, but *increased* by 0.4 percentage points in the flood insurance context. Thus, by the final round, there were fewer people selecting the safe option in the abstract context (49.5%) than initially, whereas in the flood insurance context there were more people selecting the safe option (67.1%). In both experiments, the overall increase in the proportion of people selecting the safe option with the extended time horizon compared to the short time horizon was larger in the flood insurance context (15.1%) than in the abstract context (11.4%).

It is possible that these context differences could be explained by psychological dimensions of risk perception that are not captured by these subjective probability assessments. Perceived risk is dependent on many aspects of a risk including controllability, voluntariness, and catastrophic potential (Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Slovic, 2000). Research has shown that people perceive natural disasters to be involuntary and less controllable (Brun, 1992) and that people are more accepting of voluntary/controllable risks (Fischhoff et al., 1978). This may explain why more people were willing to choose the gamble (Experiment 1) than were willing to accept the risk of a flood loss by not purchasing insurance (Experiment 2).

This finding is also consistent with people treating the flood risk as a passive risk, i.e., one they are exposed to without having to take any action, and the lottery as as an active risk where "it is possible for the individual to exert control over the outcome" (Swaton, Maderthaner, Pahner, Guttmann, & Otway, 1976, p. 8). In the abstract context, people could *avoid experiencing* the loss from the lottery by selecting the safe option, and in that sense, suffering a loss from the lottery was an active risk that was controllable. In contrast, in the flood context, people were told that, no matter what they chose, should a flood occur, they would witness and experience the loss but that the damages would be fully covered if they purchased insurance. In other words, the flood was communicated as passive and unavoidable, whereas participants had to actively opt into the abstract lottery to experience a loss.

This difference is consistent with a review of experimental studies on protecting against flood risk that observed that people behaved as if they were more risk averse in insurance contexts than in abstract contexts (Jaspersen, 2016). Individuals may want to purchase flood insurance because they are worried about a loss and want peace of mind as shown by an empirical study on the role this played in the decision to buy insurance (Schade, Kunreuther, & Koellinger, 2012) whereas there is less likely to be this feeling if one chooses to play a lottery. Despite these differences, it is important to note that the extended time horizon increased the selection of the safe option in both contexts, implying that this intervention could be applied to a broad range of risks in the real world.

Policy implications

The harm done by the BP oil spill off the Gulf Coast was felt far beyond the company and its customers. The fiasco resulted in billions of dollars lost by local businesses, countless deaths among birds, fish and other wildlife living along the coast, and immense investment by the government to repair the damage. The spill and its effects even caused a fall in housing prices along the coast near the oil spill (Hellman & Walsh, 2017). In other words, BP's failure to prepare for this rare, catastrophic event had major negative externalities. As a result, it is in society's interest to help companies like BP anticipate and internalize those externalities.

With respect to natural disasters, there are major negative externalities from the failure of residents in hazard-prone areas to undertake protective measures such as purchasing insurance or making their house safer. Individuals who do not purchase flood insurance may turn to the federal government for disaster relief. Furthermore, there may be interdependencies associated with specific risks. For example, the failure of a homeowner to strap down the water heater in their basement may cause it to topple over after an earthquake and cause a fire that affects many other homes in the neighborhood.

Tools like insurance can play an important role in encouraging individuals to invest in cost-effective loss reduction measures by reducing their premiums sufficiently so that they will want to undertake a home improvement loan where the costs of the loan is lower than the insurance premium reduction due to lower insurance claims (Kunreuther, 2015). Our evidence from three experiments suggests that stretching the time horizon associated with these negative events is likely to encourage more homeowners at risk to purchase insurance. It is reasonable to believe this might also extend to other behaviors like investing in loss reduction measures (e.g., elevating one's house or making the floors of the lower levels water resistant), which could reduce damage *ex ante*. These protective actions are likely to reduce total losses and the resulting negative externalities because more individuals will pay attention to the hazard now and gain an understanding of their financial responsibility should they suffer damage from a disaster.

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Appendix A. Experiment 1

Regression on probability assessments

To examine the effect of probability frame assignment (30-play vs. 1-play) on participants' subjective assessment of the likelihood of a loss, we estimated the following random-effects panel regression model:

$$(2)\ Assess_{ij} = \alpha + \boldsymbol{\beta_0 Round_j} + \pi_0 30play_i + \pi_1 30play_i \times \boldsymbol{Round_j} + \pi_2 30play_i \times post_{ij} + \gamma_0 post_{ij} + \gamma_1 post_{ij} \times k_{ij} + \gamma_2 post_{ij} \times late_i + \gamma_3 post_{ij} \times late_i \times k_{ij} + \mu_{ij},$$

where $Assess_{ij}$ is each participants' subjective probability assessments following rounds 1, 4, 11, and 15, $\boldsymbol{Round_j}$ is a vector of dummy variables indicating each round (with round 1 as the omitted category), $30play_i$ is the broad-bracketing assignment indicator, $post_{ij}$ is an indicator whether a loss was witnessed by the participant in any previous round (rounds 4 or 11), k_{ij} is the number of assessments that have occurred since a participant witnessed a loss, and $late_i$ is an indicator of a loss witnessed in round 11 (as compared with one witnessed in round 4).

Table A.1 Assessment of loss likelihood regressions with demographic and other controls
--- [TABLE A.1 HERE] ---

We also ran simple regressions on each of the four rounds in which probability assessments were collected to assess the immediate impact of experience on probability assessments.

Table A.2 Assessment of loss likelihood regressions with demographic and other controls, by round
--- [TABLE A.2 HERE] ---

We conducted a mediation analysis of the choice of certain loss in rounds 2, 5, and 12, where reported subjective assessment of loss likelihood in the previous round mediated the effect of broad bracketing on choices.

Table A.3 Mediation of treatment effect by subjective assessments in experiment 1, by round
--- [TABLE A.3 HERE] ---

Appendix B. Experiment 2

Pre-registered specification for regression on choices

Similar to Experiment 1, we tested the hypotheses by regressing the decision by participant *i* to purchase insurance in round *j* (*j* = 1-15) on information treatment and flood occurrence variables. With main effects and interactions, the regression model is:

(3) $purch_{ij} = \alpha + \beta_0 j + \boldsymbol{\Pi_0 treat_i} + \boldsymbol{\Pi_1 treat_i} \times j + \boldsymbol{\Pi_2 treat_i} \times post_{ij} + \gamma_0 post_{ij} + \gamma_1 post_{ij} \times k_{ij} + \gamma_2 post_{ij} \times late_i + \gamma_3 post_{ij} \times late_i \times k_{ij} + \mu_{ij},$

The variable $\boldsymbol{treat_i}$ is a vector of information treatment assignment variables (with the no SFHA/annual likelihood treatment group omitted), $post_{ij}$ is a binary indicator as to whether an individual was exposed to flood in any previous period, k_{ij} indicates the number of rounds since an individual experienced a flood, and $late_i$ is a binary indicator of those assigned to experience a flood during round 11 (that takes on the value 1) as opposed to experiencing flood during round 4 (that takes on the value 0). Participants who never experienced a flood are indicated by $post_{ij} = 0$ in all rounds. Equation (2) was estimated using random-effects linear panel regression with heteroscedasticity-consistent standard errors.

The $\boldsymbol{\Pi_0}$ parameters indicate whether information framing treatments affected the likelihood of purchasing insurance, relative to respondents assigned to the no SFHA/annual likelihood information treatment group. The null hypothesis is $\boldsymbol{\Pi_0} = 0$, indicating that information framing has no main effect on purchase behavior. The $\boldsymbol{\Pi_1}$ and $\boldsymbol{\Pi_2}$ parameters indicate whether there is any difference between the information treatment groups in the change in purchase likelihood over time (round-over-round) and following a flood, respectively. The null hypotheses of $\boldsymbol{\Pi_1} = 0$ and $\boldsymbol{\Pi_2} = 0$ suggest that information framing has no effect on purchase behavior across rounds and in response to flood occurrence.

Table B.1 Pre-registered flood insurance purchase regressions

--- [TABLE B.1 HERE] ---

Regression on probability assessments

The regressions on probability assessments for Experiment 2 mimic those done for Experiment 1. See Appendix A for more details.

Table B.2 Assessment of likelihood of flood in the next round

--- [TABLE B.2 HERE] ---

We conducted a mediation analysis of flood insurance purchases in rounds 2, 5, and 12, where reported subjective assessment of the likelihood of flood in the previous round mediated the effect of extending the time horizon on choices.

Table B.3 Mediation of treatment effect by subjective assessments in experiment 2, by round

--- [TABLE B.3 HERE] ---

Appendix C. Experiment 3

Contingency Price Ratio (R)

The equation for the contingency price ratio is as follows:

$$\frac{(1-z)p}{z(1-p)}$$

where p is the ratio of the cost of protection to the amount being protected (e.g., 500 points divided by 10,000 points), and z is the probability of loss (e.g., 0.05 for Decision 10). For more detailed information, see Kunreuther et al., 1978, pgs. 47-49.

Additional tables

--- [TABLE C.1 HERE] ---

--- [TABLE C.2 HERE] ---

--- [TABLE C.3 HERE] ---

Appendix D.

An online supplement to this paper is available at the link below, and Table D.1 summarizes its contents.

Link to online supplement:
https://osf.io/mejf5/?view_only=9b8760dca9714e85bc178f290140125e

--- [TABLE D.1 HERE] ---

Table 1. Choice of certain loss regressions with and without demographic and other controls

	No controls		With controls	
30-play probability	0.115***	(0.025)	0.114***	(0.024)
Round	-0.011***	(0.002)	-0.011***	(0.002)
Post loss	-0.005	(0.015)	-0.005	(0.015)
Time since loss	0.012***	(0.003)	0.012***	(0.003)
30-play prob. x round	0.001	(0.002)	0.001	(0.002)
30-play prob. x time since	-0.001	(0.004)	-0.001	(0.004)
Post x late loss	0.042	(0.028)	0.043	(0.028)
Post x late x time since	-0.003	(0.008)	-0.003	(0.008)
Sex: female			-0.039+	(0.023)
Sex: no answer			-0.018	(0.167)
Age			0.0002	(0.001)
Educ: HS diploma/GED			0.107	(0.171)
Educ: some college			0.142	(0.167)
Educ: 2-year coll. deg.			0.104	(0.168)
Educ: 4-year coll. deg.			0.132	(0.167)
Educ: Master's deg.			0.164	(0.169)
Educ: doctrate deg.			0.408*	(0.186)
Educ: professional deg.			0.233	(0.183)
Income			-0.0005	(0.000)
Political affiliation			-0.0005	(0.000)
Risk task investment amount			-0.003***	(0.001)
Constant	0.584***	(0.018)	0.597***	(0.170)
Observations	16,140		16,140	
Participants	1,076		1,076	
R^2	0.011		0.013	
Adjusted R^2	0.01		0.012	

Notes: Heteroskedasticity-consistent (HC1) standard errors in parentheses. Dependent variable is binary choice of certain loss over loss lottery. + p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

Table 2. Choice of certain loss regressions in round 5 and round 12

	Round 5		Round 12	
30-play probability	0.120*	(0.050)	0.101+	(0.052)
Early loss	-0.089+	(0.052)	0.073	(0.052)
Late loss	-0.01	(0.053)	0.03	(0.053)
30-play prob. x early	0.006	(0.073)	0.056	(0.072)
30-play prob. x late	-0.026	(0.073)	-0.021	(0.074)
Constant	0.652**	(0.204)	0.554**	(0.209)
Observations	1,076		1,076	
R^2	0.040		0.046	
Adjusted R^2	0.024		0.030	

Notes: Heteroskedasticity-consistent (HC1) standard errors in parentheses. Dependent variable is binary choice of certain loss over loss lottery. Demographic and other controls (sex, age, education, income, political affiliation, risk task investment) are included but not reported (available upon request) + p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

Table 3. Flood insurance purchase regressions

	No controls		With controls	
30-year probability	0.151***	-0.018	0.150***	-0.017
Round	0.003*	-0.001	0.003*	-0.001
Post flood	0.012	-0.01	0.012	-0.01
Time since flood	0.009***	-0.002	0.009***	-0.002
30-year prob. x round	-0.003*	-0.002	-0.003*	-0.002
30-year prob. x time since	0.0004	-0.003	0.0004	-0.003
Post x late flood	-0.075***	-0.017	-0.074***	-0.017
Post x late x time since	0.010*	-0.005	0.010*	-0.005
Sex: female			0.02	-0.016
Sex: no answer			0.12	-0.075
age			0.001	-0.001
Educ: HS diploma/GED			-0.115	-0.122
Educ: some college			-0.115	-0.12
Educ: 2-year coll. deg.			-0.116	-0.121
Educ: 4-year coll. deg.			-0.109	-0.12
Educ: Master's deg.			-0.098	-0.121
Educ: doctrate deg.			0.022	-0.128
Educ: professional deg.			-0.049	-0.129
Income			-0.0005*	-0.0002
Political affiliation			-0.001**	-0.0003
Flood Ins: Never purch./familiar			0.007	-0.017
Flood Ins: Purch. several times			0.006	-0.033
Flood Ins: Purch. regularly			0.071+	-0.041
Disaster: Know someone			0.039*	-0.017
Disaster: Suffered once			0.052+	-0.031
Disaster: Suffered several			-0.043	-0.068
Risk task investment amount			-0.001*	-0.0005
Constant	0.617***	-0.014	0.740***	-0.123
Observations	31,140		31,140	
Participants	2,076		2,076	
R^2	0.011		0.013	
Adjusted R^2	0.011		0.012	

Notes: Heteroskedasticity-consistent (HC1) standard errors in parentheses. Dependent variable is binary choice of flood insurance. + p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

Table 4. Flood insurance purchases in round 5 and round 12

	Round 5		Round 12	
30-year probability	0.143***	(0.034)	0.110**	(0.034)
Flood round 4	-0.074*	(0.037)	0.074*	(0.037)
Flood round 11	0.038	(0.036)	-0.008	(0.036)
30-play prob. x flood round 4	-0.018	(0.050)	0.06	(0.050)
30-play prob. x flood round 11	-0.016	(0.047)	-0.048	(0.047)
Constant	0.842***	(0.142)	0.758***	(0.142)
Observations	2,076		2,076	
R^2	0.048		0.061	
Adjusted R^2	0.037		0.050	

Notes: Heteroskedasticity-consistent (HC1) standard errors in parentheses. Dependent variable is binary choice of flood insurance. Demographic and other controls (sex, age, education, income, political affiliation, experience with flood insurance and natural disasters, risk task investment) are included but not reported (available upon request) + p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

Table 5. Probabilities and contingency price ratio associated with each of the ten decisions

Decision number	Probabilities of loss associated with the SHORT time horizon	Probabilities of loss associated with the EXTENDED time horizon	Contingency Price Ratio (R)
1	0.1%	3.0%	52.6
2	0.2%	5.8%	26.3
3	0.3%	8.6%	17.5
4	0.5%	14.0%	10.5
5	1.0%	26.0%	5.2
6	1.5%	36.5%	3.5
7	2.0%	45.5%	2.6
8	3.0%	59.9%	1.7
9	4.0%	70.6%	1.3
10	5.0%	78.5%	1.0

Table 6. Regressions of likelihood of choosing the safe option on time horizon, decision number, and risk aversion

	(1)	(2)	(3)	(4)	(5)
Intercept (Short, Decision 1, no risk aversion)	0.061*	0.147***	0.173***	0.084*	0.110*
	(0.030)	(0.039)	(0.046)	(0.042)	(0.049)
Extended time horizon	-0.0003	-0.015	-0.062	-0.008	-0.055
	(0.042)	(0.042)	(0.062)	(0.042)	(0.062)
High Stakes	0.02	0.018	0.017	0.018	0.017
	(0.039)	(0.038)	(0.038)	(0.038)	(0.038)
Decision number	0.046***	0.046***	0.046***	0.057***	0.057***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)
Risk aversion		0.0003***	0.0004**	0.0001	0.0002
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
Extended x High Stakes	0.027	0.038	0.036	0.038	0.036
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
Extended x Decision number	0.036***	0.036***	0.036***	0.034***	0.034***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Extended x Risk aversion			-0.0002		-0.0002
			(0.000)		(0.000)
DecNum x Risk aversion				0.00004***	0.00004***
				(0.00001)	(0.00001)
Observations	5,080	5,080	5,080	5,080	5,080
R2	0.245	0.246	0.246	0.248	0.248
Adjusted R2	0.244	0.245	0.245	0.247	0.247
F Statistic	328.550*** (df = 5; 5074)	276.073*** (df = 6; 5073)	236.789*** (df = 7; 5072)	239.380*** (df = 7; 5072)	209.593*** (df = 8; 5071)

Notes: Standard errors are in parentheses. Dependent variable is the binary choice of the certain loss over the lottery. * p<0.05; ** p<0.01; *** p<0.001.

Table 7. Comparison of Experiments 1 and 2

		Experiment 1 (Abstract)	**Experiment 2 (Flood)**
CHOICES			
	First-round proportion choosing safe option under short time horizon	58.4%	61.8%
	Last-round proportion choosing safe option under short time horizon	49.5%	67.1%
	EXTENDED TIME HORIZON: Average additional effect of extended time horizon on proportion choosing safe option	11.4%	15.1%
	ROUND: Average additional effect of each round on proportion choosing safe option	-1.1%	0.3%
	EARLY LOSS: Average additional effect of each round following an early loss on proportion choosing safe option	1.2%	0.9%
	LATE LOSS: Average additional effect of each round following a late loss on proportion choosing safe option	n.s.	1.0%
	ALWAYS SAFE: Proportion of people always choosing the safe option (in all 15 rounds)	30.5%	47.2%
	ALWAYS RISKY: Proportion of people always choosing the risky option (in all 15 rounds)	14.3%	10.0%
	SWITCH: Proportion of people switching at least once	55.2%	42.8%
SUBJECTIVE PROBABILITY			
	FIRST-ROUND-SHORT: Average first-round subjective probability assessments for people under the short time horizon	4.1	2.6
	FIRST-ROUND-EXTENDED: Average first-round subjective probability assessments for people under the extended time horizon	4.9	4.1
	DIFFERENCE: (extended - short)	*0.8*	*1.5*
	LAST-ROUND-SHORT: Average last-round subjective probability assessments for people under the short time horizon	3.6	2.8
	LAST-ROUND-EXTENDED: Average last-round subjective probability assessments for people under the extended time horizon	4.9	4.4
	DIFFERENCE: (extended - short)	*1.3*	*1.6*

Table A.1: Assessment of loss likelihood regressions with demographic and other controls

	No controls		With controls	
30-play probability	0.854***	(0.159)	0.886***	(0.154)
Round 4	-0.117	(0.103)	-0.116	(0.103)
Round 11	-0.138	(0.142)	-0.135	(0.143)
Round 15	-0.42*	(0.183)	-0.416*	(0.184)
Post loss	-0.413**	(0.131)	-0.415**	(0.130)
Time since loss	0.259*	(0.128)	0.256*	(0.128)
30-play prob. x round 4	0.240+	(0.130)	0.240+	(0.130)
30-play prob. x round 11	0.144	(0.169)	0.143	(0.169)
30-play prob. x round 15	-0.04	(0.242)	-0.044	(0.243)
30-play prob. x time since	0.493**	(0.181)	0.497**	(0.182)
Post x late loss	-0.207	(0.177)	-0.208	(0.176)
Post x late x time since	0.14	(0.149)	0.14	(0.149)
Sex: female			1.065***	(0.139)
Sex: no answer			0.264	(0.519)
Age			-0.009	(0.006)
Educ: HS diploma/GED			0.492	(0.874)
Educ: some college			0.527	(0.847)
Educ: 2-year coll. deg.			0.293	(0.855)
Educ: 4-year coll. deg.			0.447	(0.843)
Educ: Master's deg.			0.357	(0.859)
Educ: doctrate deg.			-0.65	(0.930)
Educ: professional deg.			-0.349	(0.947)
Income			-0.002	(0.002)
Political affiliation			0.005+	(0.003)
Risk task investment amount			-0.008+	(0.004)
Constant	4.096***	(0.122)	3.529***	(0.882)
Observations	4,304		4,304	
Participants	1,076		1,076	
R^2	0.035		0.055	
Adjusted R^2	0.033		0.049	

Notes: Heteroskedasticity-consistent (HC1) standard errors in parentheses. Dependent variable is assessment of likelihood of loss in the following round (0 = extremely unlikely, 10= extremely likely). + p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

Table A.2: Mediation of treatment effect by subjective assessments in experiment 1, by round

	Round 2	Round 5	Round 12
Mediated effect	0.009*	0.022***	0.026***
Direct effect	0.080**	0.014	0.031
Total effect	0.089***	0.037	0.057*
Proportion mediated	0.096*	0.522	0.445*

Notes: The outcome is choice of the certain loss; the treatment is the 30-round probability frame; the mediator variable is subjective assessment of the likelihood of a loss measured after the previous round. Estimates generated from simulated outcome and mediator models (N = 1,000) using 'mediation' R package (R Development Core Team, 2009); see Imai et al. (2010) for details. + p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

Table B.1: Pre-registered flood insurance purchase regressions

	No controls		With controls	
Treat 2: 30-year prob., no SFHA	0.166***	(0.025)	0.166***	(0.025)
Treat 3: 1-year prob. + SFHA	0.002	(0.027)	0.006	(0.027)
Treat 4: 30-year prob. + SFHA	0.130***	(0.025)	0.132***	(0.025)
Round	0.004**	(0.001)	0.004**	(0.001)
Post flood	0.006	(0.016)	0.007	(0.016)
Treat 2 x round	-0.005*	(0.002)	-0.005*	(0.002)
Treat 3 x round	-0.005**	(0.002)	-0.005**	(0.002)
Treat 4 x round	-0.002	(0.002)	-0.002	(0.002)
Treat 2 x post	-0.021	(0.020)	-0.021	(0.020)
Treat 3 x post	0.046*	(0.021)	0.046*	(0.021)
Treat 4 x post	-0.001	(0.021)	-0.002	(0.021)
Time since flood	0.009***	(0.002)	0.009***	(0.002)
Post x late flood	-0.075***	(0.017)	-0.074***	(0.017)
Post x late x time since	0.010*	(0.005)	0.010*	(0.005)
Sex: female			0.02	(0.016)
Sex: no answer			0.117	(0.075)
age			0.001	(0.001)
Educ: HS diploma/GED			-0.113	(0.123)
Educ: some college			-0.112	(0.121)
Educ: 2-year coll. deg.			-0.115	(0.122)
Educ: 4-year coll. deg.			-0.106	(0.121)
Educ: Master's deg.			-0.095	(0.123)
Educ: doctrate deg.			0.023	(0.129)
Educ: professional deg.			-0.046	(0.130)
Income			-0.0005*	(0.000)
Political affiliation			-0.001**	(0.000)
Flood Ins: Never purch./familiar			0.007	(0.018)
Flood Ins: Purch. several times			0.006	(0.033)
Flood Ins: Purch. regularly			0.070+	(0.041)
Disaster: Know someone			0.039*	(0.017)
Disaster: Suffered once			0.052+	(0.031)
Disaster: Suffered several			-0.043	(0.068)
Risk task investment amount			-0.001*	(0.001)
Constant	0.618***	(0.020)	0.736***	(0.126)
Observations	31,140		31,140	
Participants	2,076		2,076	
R^2	0.012		0.014	
Adjusted R^2	0.012		0.013	

Notes: Heteroskedasticity-consistent (HC1) standard errors in parentheses. Dependent variable is binary choice of flood insurance. + p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

Table B.2: Assessment of likelihood of flood in the next round

	No controls		With controls	
30-year probability	1.449***	(0.101)	1.439***	(0.097)
Round 4	0.259***	(0.057)	0.258***	(0.057)
Round 11	0.480***	(0.089)	0.475***	(0.089)
Round 15	0.201+	(0.117)	0.196+	(0.117)
Post flood	-0.725***	(0.076)	-0.719***	(0.076)
Time since flood	0.519***	(0.086)	0.520***	(0.086)
30-year prob. x round 4	0.008	(0.076)	0.008	(0.076)
30-year prob. x round 11	-0.043	(0.105)	-0.044	(0.105)
30-year prob. x round 15	-0.162	(0.157)	-0.165	(0.157)
30-year prob. x time since	0.298*	(0.119)	0.301*	(0.119)
Post x late flood	-0.369***	(0.102)	-0.366***	(0.103)
Post x late x time since	0.271**	(0.089)	0.270**	(0.089)
Sex: female			0.921***	(0.091)
Sex: no answer			0.408	(0.620)
Age			-0.014**	(0.004)
Educ: HS diploma/GED			-0.498	(0.779)
Educ: some college			-0.543	(0.768)
Educ: 2-year coll. deg.			-0.389	(0.778)
Educ: 4-year coll. deg.			-0.805	(0.767)
Educ: Master's deg.			-0.759	(0.777)
Educ: doctrate deg.			-0.585	(0.880)
Educ: professional deg.			-1.215	(0.821)
Income			-0.002	(0.001)
Political affiliation			0.003+	(0.002)
Flood Ins: Never purch./familiar			0.067	(0.102)
Flood Ins: Purch. several times			0.333+	(0.195)
Flood Ins: Purch. regularly			0.709*	(0.308)
Disaster: Know someone			0.141	(0.099)
Disaster: Suffered once			0.572**	(0.217)
Disaster: Suffered several			0.62	(0.407)
Risk task investment amount			-0.008**	(0.003)
Constant	2.603***	(0.076)	3.438***	(0.792)
Observations	8,304		8,304	
Participants	2,076		2,076	
R^2	0.080		0.099	
Adjusted R^2	0.078		0.095	

Notes: Heteroskedasticity-consistent (HC1) standard errors in parentheses. Dependent variable is assessment of likelihood of flood in the following round (0 = extremely unlikely, 10 = extremely likely). + p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

Table B.3: Mediation of treatment effect by subjective assessments in Experiment 2, by round

	Round 2	Round 5	Round 12
Mediated effect	0.025***	0.037***	0.028***
Direct effect	0.012	-0.001	-0.003
Total effect	0.037*	0.036*	0.025*
Proportion mediated	0.686*	1.016*	1.059*

Notes: The outcome is choice of flood insurance; the treatment is the 30-round probability frame; the mediator variable is subjective assessment of the likelihood of a loss measured after the previous round. Estimates generated from simulated outcome and mediator models (N = 1,000) using 'mediation' R package (R Development Core Team, 2009); see Imai et al. (2010) for details. + p<0.1; * p<0.05; ** p<0.01; *** p<0.001.

Table C.1. Likelihood of selecting the safe option (including discrete decisions)

	(1)	(2)	(3)	(4)	(5)
Intercept (Short, Decision 1, no risk aversion)	0.166***	0.252***	0.278***	0.193***	0.219***
	(0.034)	(0.042)	(0.049)	(0.049)	(0.055)
Extended time horizon	-0.034	-0.049	-0.095	-0.042	-0.089
	(0.048)	(0.047)	(0.065)	(0.048)	(0.065)
High Stakes	0.02	0.018	0.017	0.018	0.017
	(0.039)	(0.038)	(0.038)	(0.038)	(0.038)
Decision 2	0.02	0.02	0.02	0.009	0.009
	(0.030)	(0.030)	(0.030)	(0.049)	(0.049)
Decision 3	0.008	0.008	0.008	0.021	0.021
	(0.030)	(0.030)	(0.030)	(0.049)	(0.049)
Decision 4	0.024	0.024	0.024	0.105*	0.105*
	(0.030)	(0.030)	(0.030)	(0.049)	(0.049)
Decision 5	0.084**	0.084**	0.084**	0.149**	0.149**
	(0.030)	(0.030)	(0.030)	(0.049)	(0.049)
Decision 6	0.136***	0.136***	0.136***	0.224***	0.224***
	(0.030)	(0.030)	(0.030)	(0.049)	(0.049)
Decision 7	0.208***	0.208***	0.208***	0.296***	0.296***
	(0.030)	(0.030)	(0.030)	(0.049)	(0.049)
Decision 8	0.280***	0.280***	0.280***	0.380***	0.380***
	(0.030)	(0.030)	(0.030)	(0.049)	(0.049)
Decision 9	0.336***	0.336***	0.336***	0.426***	0.426***
	(0.030)	(0.030)	(0.030)	(0.049)	(0.049)
Decision 10	0.376***	0.376***	0.376***	0.454***	0.454***
	(0.030)	(0.030)	(0.030)	(0.049)	(0.049)
Risk aversion		0.0003***	0.0004**	0.0001	0.0002
		(0.000)	(0.000)	(0.000)	(0.000)
Extended x High Stakes	0.027	0.038	0.036	0.038	0.036
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
Extended x Decision 2	0.038	0.038	0.038	0.039	0.039
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Extended x Decision 3	0.124**	0.124**	0.124**	0.122**	0.122**
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Extended x Decision 4	0.209***	0.209***	0.209***	0.199***	0.199***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Extended x Decision 5	0.296***	0.296***	0.296***	0.288***	0.288***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Extended x Decision 6	0.345***	0.345***	0.345***	0.335***	0.335***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Extended x Decision 7	0.370***	0.370***	0.370***	0.360***	0.360***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Extended x Decision 8	0.360***	0.360***	0.360***	0.348***	0.348***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Extended x Decision 9	0.292***	0.292***	0.292***	0.282***	0.282***

	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Extended x Decision 10	0.267***	0.267***	0.267***	0.259***	0.259***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
Extended x Risk aversion			-0.0002		-0.0002
			(0.0002)		(0.0002)
Decision 2 x Risk aversion				-0.00004	-0.00004
				(0.0001)	(0.0001)
Decision 3 x Risk aversion				0.00004	0.00004
				(0.0001)	(0.0001)
Decision 4 x Risk aversion				0.0003*	0.0003*
				(0.0001)	(0.0001)
Decision 5 x Risk aversion				0.0002	0.0002
				(0.0001)	(0.0001)
Decision 6 x Risk aversion				0.0003*	0.0003*
				(0.0001)	(0.0001)
Decision 7 x Risk aversion				0.0003*	0.0003*
				(0.0001)	(0.0001)
Decision 8 x Risk aversion				0.0003**	0.0003**
				(0.0001)	(0.0001)
Decision 9 x Risk aversion				0.0003*	0.0003*
				(0.0001)	(0.0001)
Decision 10 x Risk aversion				0.0003*	0.0003*
				(0.0001)	(0.0001)
Observations	5,080	5,080	5,080	5,080	5,080
R2	0.259	0.26	0.26	0.263	0.264
Adjusted R2	0.256	0.257	0.257	0.259	0.259
F Statistic	84.065*** (df = 21; 5058)	80.866*** (df = 22; 5057)	77.397*** (df = 23; 5056)	58.236*** (df = 31; 5048)	56.450*** (df = 32; 5047)

Notes: Standard errors are in parentheses. Dependent variable is the choice of the safe option (0 = risky option, 1 = safe option). * p<0.05; ** p<0.01; *** p<0.001.

Table C.2. Likelihood of selecting the safe option (including risk levels)

	(1)	(2)	(3)	(4)	(5)
Intercept (Short, Decision 1, no risk aversion)	0.061*	0.002	-0.019	0.025	0.004
	(0.030)	(0.036)	(0.040)	(0.038)	(0.042)
Extended time horizon	-0.0003	-0.016	0.032	-0.006	0.041
	(0.042)	(0.042)	(0.059)	(0.042)	(0.059)
High Stakes	0.02	0.016	0.013	0.016	0.013
	(0.039)	(0.038)	(0.039)	(0.038)	(0.039)
Decision number	0.046***	0.046***	0.046***	0.042***	0.042***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Low risk aversion		0.079*	0.102	0.117*	0.140*
	(0.040)	(0.055)	(0.049)	(0.062)	
Medium risk aversion		0.071*	0.108*	0.032	0.069
	(0.036)	(0.050)	(0.043)	(0.055)	
High risk aversion		0.129***	0.163**	0.034	0.068
	(0.037)	(0.054)	(0.044)	(0.060)	
Extended x High Stakes	0.027	0.039	0.04	0.039	0.04
	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
Extended x Decision number	0.036***	0.036***	0.036***	0.034***	0.034***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Extended x Low risk aversion			-0.05		-0.05
			(0.081)		(0.081)
Extended x Medium risk aversion			-0.078		-0.078
			(0.072)		(0.072)
Extended x High risk aversion			-0.068		-0.068
			(0.074)		(0.074)
DecNum x Low risk aversion				-0.007	-0.007
				(0.005)	(0.005)
DecNum x Medium risk aversion				0.007	0.007
				(0.004)	(0.004)
DecNum x High risk aversion				0.017***	0.017***
				(0.005)	(0.005)

Observations	5,080	5,080	5,080	5,080	5,080
R2	0.245	0.246	0.246	0.25	0.25
Adjusted R2	0.244	0.245	0.245	0.248	0.248
F Statistic	328.550*** (df = 5; 5074)	207.070*** (df = 8; 5071)	150.701*** (df = 11; 5068)	153.616*** (df = 11; 5068)	120.780*** (df = 14; 5065)

Notes: Standard errors are in parentheses. Dependent variable is the choice of the safe option (0 = risky option, 1 = safe option). * p<0.05; ** p<0.01; *** p<0.001.

Table C.3. Likelihood of selecting the safe option (including discrete decisions and risk levels)

	(1)	(2)
Intercept (Short, Decision 1, no risk aversion)	0.130**	0.109*
	(0.044)	(0.048)
Extended time horizon	-0.04	0.007
	(0.048)	(0.063)
High Stakes	0.016	0.013
	(0.038)	(0.039)
Decision 2	0.029	0.029
	(0.044)	(0.044)
Decision 3	0.005	0.005
	(0.044)	(0.044)
Decision 4	-0.024	-0.024
	(0.044)	(0.044)
Decision 5	0.065	0.065
	(0.044)	(0.044)
Decision 6	0.105*	0.105*
	(0.044)	(0.044)
Decision 7	0.174***	0.174***
	(0.044)	(0.044)
Decision 8	0.226***	0.226***
	(0.044)	(0.044)
Decision 9	0.305***	0.305***
	(0.044)	(0.044)
Decision 10	0.356***	0.356***
	(0.044)	(0.044)
Low risk aversion	0.079	0.102
	(0.059)	(0.070)
Medium risk aversion	0.059	0.096
	(0.052)	(0.062)
High risk aversion	0.033	0.068
	(0.054)	(0.067)
Extended x High Stakes	0.039	0.04
	(0.054)	(0.054)
Extended x Decision 2	0.039	0.039
	(0.043)	(0.043)
Extended x Decision 3	0.121**	0.121**
	(0.043)	(0.043)
Extended x Decision 4	0.199***	0.199***
	(0.043)	(0.043)
Extended x Decision 5	0.286***	0.286***
	(0.043)	(0.043)
Extended x Decision 6	0.331***	0.331***
	(0.043)	(0.043)
Extended x Decision 7	0.356***	0.356***

	(0.043)	(0.043)
Extended x Decision 8	0.346***	0.346***
	(0.043)	(0.043)
Extended x Decision 9	0.278***	0.278***
	(0.043)	(0.043)
Extended x Decision 10	0.255***	0.255***
	(0.043)	(0.043)
Extended x Low risk aversion		-0.05
		(0.081)
Extended x Medium risk aversion		-0.078
		(0.072)
Extended x High risk aversion		-0.068
		(0.074)
Low Risk Av x Decision 2	0.007	0.007
	(0.063)	(0.063)
Low Risk Av x Decision 3	-0.018	-0.018
	(0.063)	(0.063)
Low Risk Av x Decision 4	0.072	0.072
	(0.063)	(0.063)
Low Risk Av x Decision 5	0.03	0.03
	(0.063)	(0.063)
Low Risk Av x Decision 6	0.012	0.012
	(0.063)	(0.063)
Low Risk Av x Decision 7	0.018	0.018
	(0.063)	(0.063)
Low Risk Av x Decision 8	0.025	0.025
	(0.063)	(0.063)
Low Risk Av x Decision 9	-0.065	-0.065
	(0.063)	(0.063)
Low Risk Av x Decision 10	-0.073	-0.073
	(0.063)	(0.063)
Med Risk Av x Decision 2	-0.027	-0.027
	(0.056)	(0.056)
Med Risk Av x Decision 3	0.006	0.006
	(0.056)	(0.056)
Med Risk Av x Decision 4	0.031	0.031
	(0.056)	(0.056)
Med Risk Av x Decision 5	-0.036	-0.036
	(0.056)	(0.056)
Med Risk Av x Decision 6	-0.006	-0.006
	(0.056)	(0.056)
Med Risk Av x Decision 7	-0.002	-0.002
	(0.056)	(0.056)

Med Risk Av x Decision 8	0.058	0.058
	(0.056)	(0.056)
Med Risk Av x Decision 9	0.063	0.063
	(0.056)	(0.056)
Med Risk Av x Decision 10	0.038	0.038
	(0.056)	(0.056)
High Risk Av x Decision 2	-0.014	-0.014
	(0.058)	(0.058)
High Risk Av x Decision 3	0.024	0.024
	(0.058)	(0.058)
High Risk Av x Decision 4	0.123*	0.123*
	(0.058)	(0.058)
High Risk Av x Decision 5	0.115*	0.115*
	(0.058)	(0.058)
High Risk Av x Decision 6	0.149*	0.149*
	(0.058)	(0.058)
High Risk Av x Decision 7	0.151**	0.151**
	(0.058)	(0.058)
High Risk Av x Decision 8	0.159**	0.159**
	(0.058)	(0.058)
High Risk Av x Decision 9	0.130*	0.130*
	(0.058)	(0.058)
High Risk Av x Decision 10	0.116*	0.116*
	(0.058)	(0.058)
Observations	5,080	5,080
R2	0.267	0.268
Adjusted R2	0.26	0.26
F Statistic	35.988*** (df = 51; 5028)	34.010*** (df = 54; 5025)

Notes: Standard errors are in parentheses. Dependent variable is the choice of the safe option (0 = risky option, 1 = safe option). * p<0.05; ** p<0.01; *** p<0.001.

Table D.1. Index of online supplementary material