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Why Do We Want to Delay Actions on Climate Change? Effects of Probability and Timing of Climate Consequences

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ABSTRACT

This research tests people's support for the ''wait-and-see'' approach in climate change due to the uncertainty in both the timing and probability of future consequences. In a laboratory experiment, carbon-tax consequences were presented to participants in one of two forms: a written description, where the probability, consequences, and timing were explicitly provided; and experience, where the probability, consequences, and timing were sampled through unlabeled buttons. Four problems were presented in each condition such that the probability of consequences was high or low and the timing was early or late. Results indicated that the proportion of wait-and-see choices was greater in experience than description. Furthermore, in both experience and description, the proportion of wait-and-see choices was greater when the probability was low rather than high. The difference in the proportion of wait-and-see choices between the low and high probability was amplified in experience and attenuated in description. Finally, there was no difference in the proportion of wait-and-see choices when the timing of climate consequences was early rather than late in both experience and description. These results are explained by people's risk and time preferences. Copyright © 2010 John Wiley & Sons, Ltd.

KEY WORDS time; probability; wait-and-see; decisions from experience; decisions from description; climate change

INTRODUCTION

Unlike other problems with risky outcomes, the problem of climate change is a global problem and one where consequences are both delayed and uncertain (Sterman, 2008; Weber, 2006). Despite the seriousness of the problem, a large number of people, including citizens, policy makers, and scientists, prefer to take risks and wait rather than act now on the problem's mitigation (i.e., they exhibit a ''wait-and-see'' approach to climate change) (Dutt & Gonzalez, 2009; Nordhaus, 1994; Sterman, 2008; Sterman & Booth Sweeney, 2002, 2007).

A 2007 U.N. survey found that a majority of respondents advocate a wait-and-see or go-slow approach to emission reductions (Leiserowitz, 2007; Sterman, 2008). This wait-and-see approach is directly related to people's risk-taking behavior: people that are more risk-taking also show more wait-and-see behavior toward climate change (Leiserowitz, 2006). Policymakers also seem to prefer to take risks: ''slow the growth of greenhouse gas emissions, and—as the science justifies—stop, and then reverse that growth'' (G. Bush, 2/14/02; Jones, 2002). In fact, the wait-and-see approach has been a predominant policy in the U.S., and as a result, the U.S. is the second highest emitter of CO_2 greenhouse gas in the world (i.e., 20% of world CO_2 emissions just after China) (Vidal & Adam, 2007). A comparison of the wait-and-see approach between the U.S. and E.U. reveals that a greater proportion of people express the need to act now on climate change in the E.U. than in the U.S. (Leiserowitz, 2007). In the E.U., the governments have already acknowledged a 20% decrease in emissions by the year 2020 and are now pressing for a 30% reduction in emissions, while the U.S. has still to consider such a commitment (Feldman, 2010).

In contrast to the overwhelming amount of research done in engineering and climate sciences, very little work has been done in the behavioral sciences to understand why people would prefer to wait-and-see rather than act now (APA, 2009). Support for the wait-and-see approach may be influenced by the uncertainties in both the timing (e.g., how early in the future would we experience negative consequences due to climate change?) and the probability of occurrence of the future climate consequences (e.g., what is the likelihood of the future climate consequences?) (The Economist, 2010). These uncertainties are somewhat driven by the lack of consensus among climate experts on the probability and timing of future climate consequences (Nordhaus, 1994). For example, according to the IPCC (2007), the average sea level is expected to rise by 18–59 cm in 2090–2099 relative to 1980–1999; however, more recent estimates indicate an accelerated melting of ice and a range between 50 and 140 cm in the same time period (Rahmstorf, 2008). Given all the uncertainties, people may prefer to take a risky approach, i.e., wait-and-see rather than act now on climate mitigation.

According to Nordhaus (1994), people's support for the wait-and-see approach may also be due to their *lack* of ''experience and exposure'' to the negative consequences of the earth's climate. Recent research has suggested that human experience can often be a double-edged sword: Whether experience increases or decreases the wait-and-see approach may be determined by the nature of an individual's experience. In a simulation-based laboratory experiment, Dutt and Gonzalez (2010) provided participants with realistic and negative experiences of future accumulation of CO_2 concentration. Participants were asked to control the

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CO_2 concentration in the atmosphere in a simulation called the ''dynamic climate change simulation'' (DCCS). Participants that were exposed to DCCS showed a lower proportion of wait-and-see choices in a follow-up task, compared to participants without experiences in the DCCS. Thus, an immediate and certain experience of CO_2 concentrations and the difficulties associated with its stabilization in the DCCS reduced the proportion of wait-and-see choices compared to no experience at all. Unlike the exposure to immediate and certain experiences in a laboratory-based simulation, however, experiences of climate change in the real world are much delayed and uncertain, and exposure to realistic climate consequences can vary considerably from individual to individual. Thus, day-to-day personal experiences do not always agree with the scientific descriptions and predictions of future climate consequences: when there is two feet of snow on the ground, a person perceives the threat of climate change as far-off. For example, the recent ''snowmageddon'' in Washington, DC was sufficient enough for several congressmen to set back progress on an energy and climate bill pending legislation in Congress (Condon, 2010). Furthermore, given the uncertainties and complexity of the earth's climate, people seem to rely more on their recent day-to-day experiences, rather than on the scientific predictions and written descriptions about the catastrophic consequences of climate change in the future. This behavior is supported by recent findings suggesting that as the complexity of a problem increases, people rely more on their own experience rather than on a written description of a risky situation (Lejarraga, 2010).

Motivated by the above observations, this research aims at understanding human decisions to ''wait-and-see'' or ''act-now'' when they are asked to experience different probabilities and timings of future climate consequences compared to when they are presented with a written description of the same. In this study, in a laboratory experiment, people make wait-and-see (risk-taking) or act-now (risk-averse) choices based on an experience or based on a written description of the future consequences of climate change. The experiment is a direct application of established Judgment and Decision Making (JDM) principles to the problem of wait-and-see on climate, and an extension of those findings that bring together the effects of the probability and timing of consequences on decisions from description and experience.

In the past, literature in JDM has either considered the influence of probability that is presented as a description or experience on people's decisions without considering the timing of consequences (Hertwig, Barron, Weber, & Erev, 2004; Kahneman & Tversky, 1979), or it has considered the influence of the timing of consequences as a description or experience on people's decisions without considering the probability (Loewenstein & Elster, 1992; Madden, Begotka, Raiff, & Kastern, 2003; Thaler, 1981). Thus, the contribution of this paper to JDM is unique and the climate problem is ideally suited for investigating the *joint* effects of probability and timing on people's decisions, as the future climate consequences are both delayed in time and are uncertain.

In what follows, we first summarize the JDM research relevant to generating our hypotheses about human behavior when making decisions from an experience or from a written description in situations that vary in the probability and timing of future climate consequences. Next, we present a laboratory experiment that manipulates the presentation of probability and timing in the form of an experience or a written description. Then, we present the results of this experiment and discuss the implications of the results to policy and JDM research.

Decisions from description and experience: Effects of probability and timing

Current research in JDM has documented the differences in human risk-taking behavior when making decisions from experience or decisions from description (e.g., Hertwig et al., 2004; Hertwig, in press). In decisions from description, people are asked to choose between two alternatives described by their consequences and probabilities. In contrast, in decisions from experience, people make repeated decisions by clicking on two unlabeled buttons (representing two alternatives) (Barron & Erev, 2003), or sample the consequences as many times as they wish before making a final choice for one of the two alternatives (Hertwig et al., 2004).

The main finding from this literature is that when making decisions from experience, people behave as if the low probability consequences have less impact than they deserve according to their objective probabilities, whereas in decisions from description people behave as if the low probability consequences have more impact than they deserve (consistent with the predictions from cumulative prospect theory) (Hau, Pleskac, Kiefer, & Hertwig, 2008; Hertwig, in press; Hertwig & Erev, 2009; Hertwig et al., 2004; Weber, Shafir, & Blais, 2004). As a result, the risk-taking behavior predicted by prospect theory in decisions from description gets reversed in decisions from experience. The reversal of people's risk-taking behavior has been attributed to the reliance on small samples in decisions from experience (Gottlieb, Weiss, & Chapman, 2007; Hertwig et al., 2004; Rakow, Demes, & Newell, 2008; Ungemach, Chater, & Stewart, 2009); differential impact of low and high probability consequences in gamble problems (Hau et al., 2008); and reliance on observed recent and frequent experiences of consequences (Gonzalez & Dutt, 2010; Hertwig, in press; Lejarraga, Dutt, & Gonzalez, in press; Weber et al., 2004).

The change in people's risk preferences documented in decisions from experience and description is highly relevant to our understanding of people's support for the wait-and-see approach for climate. As explained above, a written description of the probability and the timing of future climate consequences do not always agree with a person's day-to-day experiences of climate consequences. Currently, climate change might be perceived as a low probability event because the consequences are delayed and there is considerable individual variability of human experiences. For example, a consequence of climate change is a reduction of glaciers in the Himalayas, but the reduction happens slowly and most people living in cities do not experience it.

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Thus, people might perceive future climate consequences as low probability events that have a negligible chance of occurring in the future. According to the JDM literature, we expect people to behave as if future climate consequences have less impact than they deserve according to their objective probabilities, when making decisions from experience. Similarly, we expect people to behave as if the future climate consequences have more impact than they deserve according to their objective probabilities, when making decisions from a written description. Thus, we hypothesize that

H1 **:** The proportion of wait-and-see choices will be greater when decisions are made from experience than from a written description.

Literature in JDM has also documented people's risk-taking choices to be a function of both the probability of a consequence (low probability or high probability) and of the sign of the consequence (loss consequence or gain consequence) (Kahneman & Tversky, 1979; Tversky & Fox, 1995; Tversky & Kahneman, 1992). The basic finding is a ''fourfold pattern'' (Hertwig, in press): In decisions from description, people are risk-taking when the probability of a loss is high and when the probability of a gain is low. Similarly, people are risk averse when the probability of a gain is high and when the probability of a loss is low (Tversky & Fox, 1995). This fourfold pattern of risk-taking and risk-aversion in decisions from description has been replicated in many studies in the past (Cohen, Jaffray, & Said, 1987; Fishburn & Kochenberger, 1979; Hershey & Schoemaker, 1980; Kahneman & Tversky, 1979). The fourfold pattern has been explained as per the tenets of prospect theory (Kahneman & Tversky, 1979), which suggests that the utility of a gamble problem is the product of a value function with a probability-weighting function. The shape of the value function is concave for gains and convex for losses, relative to a common reference point. In addition, the shape of the probability-weighting function is nonlinear such that low probability consequences have more impact than they deserve according to their objective probabilities and moderate and high probability consequences have less impact than they deserve according to their objective probabilities.

In decisions from experience, researchers have shown a reversal of the fourfold pattern observed in decisions from description (Hertwig et al., 2004): People are risk-taking when the probability of a gain is high, but risk-averse when it is low. At the same time, they are risk-taking when the probability of a loss is low, but risk-averse when it is high (Hertwig, in press). Although it might become difficult to explain people's risk-taking behavior in decisions from experience according to the prospect theory in a form that theory was originally proposed (Kahneman & Tversky, 1979), researchers have tried to apply the prospect theory to decisions from experience by recalibrating the theory's parameters (Hau et al., 2008). Thus, the recalibrated weighting and value functions in the prospect theory are able to account for the observations in decisions from experience (in fact the recalibration makes the theory provide one of the best accounts for results in decisions from experience). However, the recalibrated parameters in decisions from experience also turn the weighting function into an identity function of probability and this questions whether the essence of the theory is retained, post-recalibration (Hau et al., 2008; Hertwig, in press).

An act-now approach to climate change requires paying a cost (e.g., a carbon-tax), and thus, an act-now approach demands a monetary loss right now. In contrast, a wait-and-see approach to climate change, with some probability of occurring in the future, might entail losing a larger sum of money (e.g., as a tax). Given the inverse predictions of risk-taking behavior in decisions from description and experience, we expect that in description, people would prefer to wait-and-see (i.e., behave risk-taking) when they are presented with a carbon-tax payment that has a high probability of occurrence in the future, but people would prefer to act-now (i.e., behave risk-averse) when they are presented with a tax payment that has a low future probability of occurrence. In contrast, in experience, people would prefer to wait-and-see when they experience a carbon-tax payment that has a low probability of occurrence in the future, but would prefer to act-now when they experience one that has a high probability of occurrence in the future. Thus, the proportion of wait-and-see choices should be greater when the probability of tax payment is low and should be smaller when the probability of tax payment is high. Therefore, in experience, the difference in the proportion of wait-and-see choices between a low and a high probability tax payment will be amplified compared to description. In description, the difference in the proportion of wait-and-see choices between a low and high probability tax payment will be attenuated.

We hypothesize that

H2 **:** The difference in the proportion of wait-and-see choices between a low probability and a high probability climate consequence will be greater when making decision from experience than when making decision from description.

In addition to the uncertainty in the occurrence of future climate consequences, there is also an uncertainty and lack of consensus on the timing of the consequences (e.g., how soon from now the climate consequences are expected to appear) (Nordhaus, 1994). As mentioned above, the decisions from experience and description paradigms in JDM have been used to assess the effects of the probability and timing of future consequences independently; the paradigms have still not been used to assess the joint effects of the probability and timing on people's risk preferences. According to the literature in time preferences, a person tends to avoid a high and certain cost *now* (e.g., defer an increase in tax) when the associated benefits are distant in the future (magnitude effect) (Ainslie, 1975; Loewenstein & Elster, 1992; Thaler, 1981; Weber, 2006). However, a wait-and-see decision in the

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climate problem may also be influenced by the ''discount rate'' (the interest rate used to determine the present value of future tax payments) (dynamic-inconsistency effect) (Benzion, Rapoport, & Yagil, 1989). Due to the magnitude and dynamic-inconsistency effects, a person's discount rate falls with an increase in time to pay a tax amount and an increase in magnitude of the tax amount.

The carbon-tax one would have to pay to mitigate climate change is predicted to grow as one decides to follow a wait-and-see approach (Stern, 2006). The nature of growth of the carbon-tax is nonlinear with small increments in the carbon-tax early in the future and larger increments late in the future (Stern, 2006). Thus, we expect that someone would prefer to pay a smaller carbon-tax now, rather than to pay a very large carbon-tax late in the future. Because of the nonlinear increase in the carbon-tax with increase in time, the tax one would need to pay early in the future (e.g., 10 years from now) might not be much larger than the carbon-tax one would need to pay right now. Therefore, one might decide to wait and pay the tax later in the future (wait-and-see) rather than pay it right now (act-now).

Previous research has tested the effects of providing a time delayed monetary reward on people's time-preferences when the reward was presented either as a hypothetical reward (a written description of a delay in getting a reward) or as a real reward (an actual experience of the delay in getting a reward) (Madden et al., 2003). In their study, half of the participants were tested first with hypothetical rewards and then with real rewards; the other half were tested first with real rewards and then with the hypothetical rewards. In all cases, the amount of reward that could be won was \$10, which was offered to a participant at different time delays. Participants were asked to choose one of the two alternatives: ''\$*X* delivered today and \$10 delivered in *Y* years.'' The \$*X* corresponded to an immediate reward and \$10 corresponded to a delayed reward. For the hypothetical rewards, participants did not receive any of the rewards that they chose in different problems. In contrast, for the real rewards, the reward was physically delayed and mailed out to participants after a time delay (*Y*), if participants had selected to delay the reception of the reward in a randomly selected problem. According to Madden et al. (2003) there was no difference in the amount of reward for which a participant switched from an immediate reward to a delayed reward between the real and hypothetical rewards. Madden et al.'s (2003) intervention of a real time delay corresponds to a situation in which people are exposed to the timing as an experience, while the hypothetical time delayed rewards corresponds to a descriptive situation in which people read a written description on how long they would need to wait for the reward.

Although Madden et al.'s (2003) study is about monetary rewards rather than monetary losses as in the current study, we believe that Madden et al.'s (2003) study gives some evidence that time preferences in description and experience would be similar. According to this and the literature in time preferences, we hypothesize that

H3 **:** The proportion of wait-and-see choices will be greater when climate consequences are expected to occur early rather than late in the future, and this effect will be the same whether the time is experienced or described.

EXPERIMENT

We conducted a laboratory experiment to test participants' wait-and-see or act-now choices in a climate problem where they had to make decisions based on a written description or from an experience, and under different conditions of the probability and timing of climate consequences.

Method

Experimental design

Participants were randomly assigned to one of two conditions: *description* and *experience*. In the *description* condition, participants read a written description of climate consequences, probabilities, and timing of the occurrence of consequences in two different alternatives, and were asked to choose one of the alternatives based on the description ($N = 51$). Thus, the consequences, probability, and timing were explicitly given in a written form to the participants. In the *experience* condition, participants sampled two different alternatives presented as unlabeled buttons as many times as they wanted to, and were then asked to finally choose one of the two alternatives ($N = 50$). The probability and timing of climate consequences were not explicitly provided, but they were determined by participants based upon their sampling. In both conditions, one alternative reflected the wait-and-see (risk-taking) approach and the other alternative, the act-now (risk-averse) approach.

Each participant received four problems in a random order, where the wait-and-see alternative differed according to the probability and timing of the climate consequences: a low probability consequence early ($p = 0.05$ and $n = 10$ years from now); a low probability consequence late ($p = 0.05$ and $n = 100$ years from now); a high probability consequence early ($p = 0.95$ and $n = 10$ years from now); and, a high probability consequence late ($p = 0.05$ and $n = 100$ years from now).

Each alternative presented consequences as a monetary outcome, which was derived in terms of a carbon-tax.[1] The carbon-tax was determined by using a popular *Stern Review* proposal for mitigating future climate change (Stern, 2006). The Stern Review proposal was run in the Dynamic Integrated Climate Economy model (Nordhaus, 2008) with the Stern assumption of a 1.4% discount rate.[2] The model gave a carbon-tax of \$1,400 per-person-per-year for the act-now alternative. Furthermore, for the wait-and-see alternative, the model run gave a carbon-tax of \$18,000 per-person-per-year for 10 years in the future from now and

[1]The carbon-tax takes into account both the cost of damages due to future climate change as well as its cost of abatement.

[2]The output from the DICE model run contained a carbon-tax in units of dollar per ton of carbon. Thus, for generating the dollar per-person-per-year carbon-tax, an average of 5 tons of carbon consumption per-person-per-year was assumed. Furthermore, the carbon-tax in units of dollar per ton of carbon was multiplied by 5 tons of carbon consumption per-person-per-year.

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Figure 1. The four problems presented to each participant in the description condition

$340,000 per-person-per-year for 100 years in the future from now. These carbon-taxes were used as the outcomes in all problems in different conditions.

The description condition. The four problems used in the description condition are shown in Figure 1. The wait-and-see and act-now alternatives were randomly assigned to be shown on the right or left of the computer screen. A participant read and chose one of the two alternatives in each of the four problems, presented one-by-one in random order. In the act-now alternative, a person had to pay a one-time carbon-tax of $1,400 now for sure. In contrast, in the wait-and-see alternative, Y years from now (= 10 in the early case or = 100 in late case), a person had to pay a one-time carbon-tax of $\$X$ (= $18,000 in the early case or $340,000 in the late case) with a probability p (= .05 for low or = .95 for high), or $0 otherwise.

The experience condition. In the experience condition, a participant clicked one of two unlabeled buttons (Figure 2). Each button corresponded to one of the two alternatives, act-now or wait-and-see. Clicking on one of the buttons gave a participant a carbon-tax (= $1,400, if the button assigned to the act-now alternative was chosen). Clicking on the other button gave the participant another carbon-tax ($\$X$ and $0). The value of $X could be either $18,000 in the early case, or $340,000 in the late case, in the four problems. Furthermore, clicking the wait-and-see alternative delayed the presentation of the carbon-tax by a certain number of years, depending on the timing ($Y = 10$ years in the early case or Y = 100 years in the late case). One year corresponded to a 1-second of real time-delay. The 1-second to 1-year correspondence is motivated by previous time preference studies with monkeys where a similar magnitude of delay had been used (McClure, Ericson, Laibson, Loewenstein, & Cohen, 2007). Participants were first encouraged to sample both button options as many times as they wanted to, to gain experience in a problem. Sampling essentially meant clicking on one of the two buttons to find out the carbon-tax that a participant would have to pay and to experience the corresponding time delay. A participant was asked to make a final choice by clicking the ''Make Decision'' button after he was satisfied with his sampling. Although sampling the alternatives in a problem did not cost the participants money, it involved different time costs depending on the timing (early, late).

To test H1, we compared the proportion of wait-and-see choices across the experience and description conditions. To

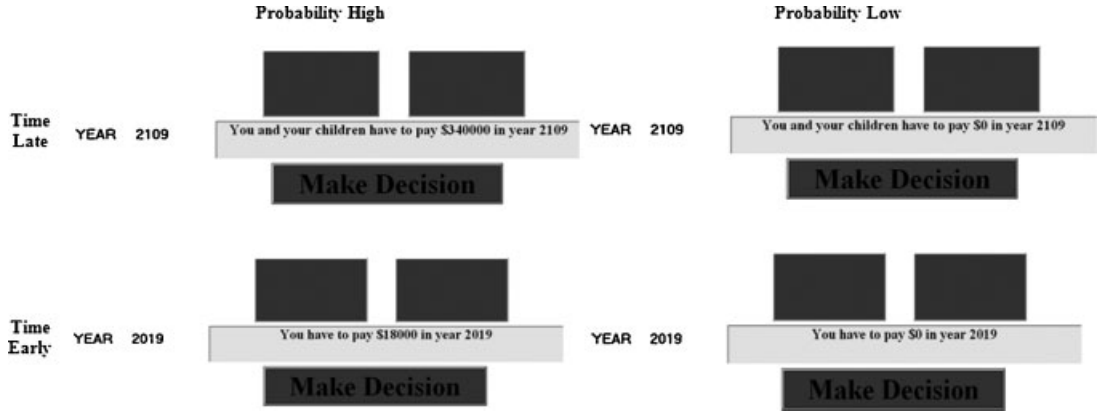

Figure 2. The four problems presented to each participant in the experience condition. The two choice alternatives in each problem were presented as two blank buttons that could be sampled many times by clicking in the buttons. Once a participant had sampled both buttons many times, a final decision could be made by clicking the ''Make Decision'' button followed by the button the participant wanted to choose

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test H2, we compared the difference between the proportion of wait-and-see choices in the low probability problems ($p = 0.05$) and the proportion of wait-and-see choices in the high probability problems ($p = 0.95$) within the experience and description conditions, respectively. Finally, to test H3, we compared the proportion of wait-and-see choices between problems where the timing was early or late, within the experience and description conditions, respectively.

Participants

One hundred and one undergraduate and graduate students at Carnegie Mellon University participated in this experiment. Sixty-two percent of the participants were males. Ages ranged from 18 years to 57 years (Mean = 25, $SD = 8$). All participants started with \$7 and depending upon their final choice, they could lose money. Only a participant's final choice in both the experience and description conditions affected the final payment. Participants were told this fact in the instructions before the start of their experiment. The carbon-taxes could be \$1,400 in the act-now and \$0, \$18,000, or \$340,000 in the wait-and-see alternative. To pay participants, we scaled the actual carbon-taxes to smaller amounts. We used a log scaling to calculate a participant's earnings in the experiment. For example, if due to a participant's final decision in a problem, the carbon-tax generated was \$X, then the adjustment to the earnings was $= -0.1 * \text{Log}_{10}(\$X + 1)$. Thus, for a \$1,400 tax, a participant lost ¢31. Similarly, for an \$18,000 or a \$340,000 tax, a participant lost ¢43 and ¢55, respectively. The log scaling ensured that none of the participants lost an amount greater than \$2 in total depending upon the final carbon-tax they would have to pay in each problem. Also, the use of the log scaling ensured that the effect of differences in the magnitudes of \$1,400, \$18,000, and \$340,000 was similar in the final payment that a participant received. The log scaling was not revealed to participants, but they were told that they might lose up to \$2 depending upon their final decisions in the problems.

Procedure

Participants read the instructions that appeared on a computer terminal. The experimenter answered any questions before the participant could begin the experiment. As part of the instructions, participants were told to assume that ''they earn a compensation of \$55,000 in 2009'' in each problem presented to them (this was the value for the average per-person-per-year salary projected for 2009 according to the year 2000 U.S. census).

Results

Across the four problems in the two conditions, experience and description, there was a significantly greater proportion of wait-and-see choices in the experience condition (47%) than in the description condition (33%), $\chi^2(1) = 8.44$, $p < .01$, $r^3 = .15$. This result supports H1.

Figure 3 presents the proportion of wait-and-see choices in the experience and description conditions according to the probability of the occurrence of consequences (low or high). In experience, there was a significant difference in the proportion of wait-and-see choices when the probability was low (74%) compared to when the probability was high (20%), $\chi^2(1) = 58.53$, $p < .001$, $r = .54$. Similarly, in description, there was a significant difference in the proportion of wait-and-see choices when the probability was low (50%) than when the probability was high (14%), $\chi^2(1) = 29.45$, $p < .001$, $r = .38$. Furthermore, in support of our expectation in H2, the difference in the proportion of wait-and-see choices between the low and high probability (54%) in the experience condition is greater than the difference in the proportion of wait-and-see choices between the low and high probability (36%) in the description condition ($r_{\text{experience}} (= .54) > r_{\text{description}} (= .38)$).

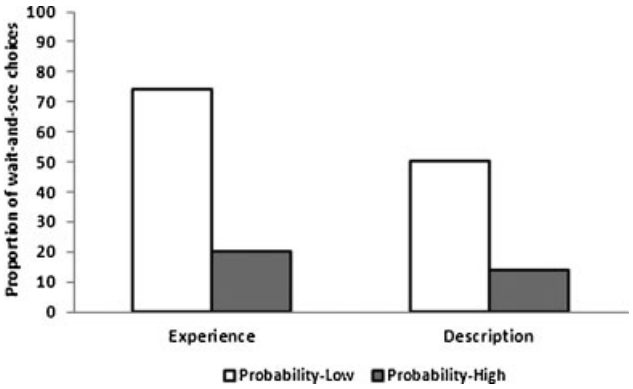

Figure 3. The proportion of final wait-and-see choices in the experience and description conditions according to the probability of occurrence of future climate consequences (low or high)

Figure 4 presents the proportion of wait-and-see choices in the experience and description conditions according to the timing of the climate consequences (early or late). In experience, the difference in the proportion of wait-and-see choices when the timing of consequences was early (52%) than late (42%) was not significant, $\chi^2(1) = 2.01$, ns, $r = .10$. Similarly, in description, the difference in the proportion of wait-and-see choices when the timing of consequences was early (37%) than late (28%) was not significant, $\chi^2(1) = 1.81$, ns, $r = .09$. Thus, H3 is not supported.

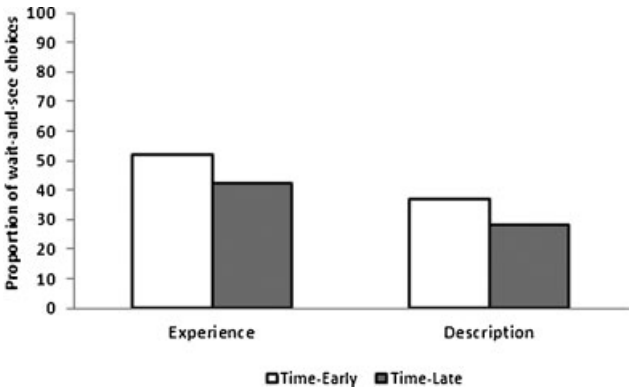

Figure 4. The proportion of final wait-and-see choices in the experience and description conditions according to the timing of the climate consequences (early or late)

[3]The r refers to the effect-size unless otherwise indicated.

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Although we did not have a prediction for the interaction between the timing and probability of future climate consequences, we present the combined effects of probability and timing in Figure 5. This figure shows the proportion of wait-and-see choices for each of the four problems used in our experiment. The proportion of wait-and-see choices was greater in experience than in description conditions in all cases except for these two: when the probability of the consequence was high and the time was late and when the probability of consequence was high and the time was early. When the probability of the consequence was high and the time was late, there were 10% wait-and-see choices in experience and 12% wait-and-see choices in description ($\chi^2(1) = 0.13$, *ns*, $r = .04$). Similarly, when the probability of the consequence was high and the time was early, there were 30% wait-and-see choices in experience and 16% wait-and-see choices in description ($\chi^2(1) = 2.59$, *ns*, $r = .16$). However, when the probability of the consequence was low and the time was early, the proportion of wait-and-and-see choices was significantly greater in the experience condition (74%) than in the description condition (55%), $\chi^2(1) = 3.99$, $p < .05$, $r = .19$. Similarly, when the probability of the consequence was low and the time was late, the proportion of wait-and-and-see choices was significantly greater in the experience (74%) than the description (44%) condition, $\chi^2(1) = 9.30$, $p < .01$, $r = .31$. These results suggest that the wait-and-see choices were directly affected by the low probability of the consequences and not by the time. When the probability of the climate consequences is high, there is a smaller proportion of wait-and-see choices regardless of the time.

Sampling in experience

Across all four cases in the experience condition, participants sampled both alternatives less than five times on average (thus, the sample size was very small). The median number of samples of the act-now alternative was: two for late-and-high case, one for late-and-low case, one for early-and-high case, and one for early-and-low case. Similarly, the median number of samples of the wait-and-see alternative was: one for late-and-high case, one for late-and-low case, one for early-and-high case, and two for early-and-low case. Although the timing of the climate consequences did not affect the proportion of wait-and-see choices (see results above), the timing did affect the sampling of the wait-and-see alternative (the effect of the timing on the act-now alternative was absent with $z = -0.60$, $p = .55$, and $r = .04$). Remember, the timing was only manipulated in the wait-and-see alternative and not in the act-now alternative. The number of samples in the wait-and-see alternative for an early timing of consequence (mean = 1.76) was significantly greater than the number of samples of the wait-and-see alternative for a late timing (mean = 1.39) with $z = -2.31$, $p = .02$, and $r = .16$. Furthermore, there was an effect of the probability of the future climate consequences on the number of samples in the act-now alternative (the effect of the probability of the climate consequences on the number of samples of the wait-and-see alternative was absent with $z = -1.48$, $p = .14$, and $r = .10$). The number of samples in the act-now alternative for a high probability of consequence (mean = 1.95) was significantly greater than the number of samples of the act-now alternative for the low probability (mean = 1.32) with $z = -3.14$, $p < .01$, and $r = .22$. Thus, it was as if a participant who encountered the high probability consequence on the wait-and-see alternative, also wanted to check the consequence in the act-now alternative more often than the wait-and-see alternative before making his final choice.

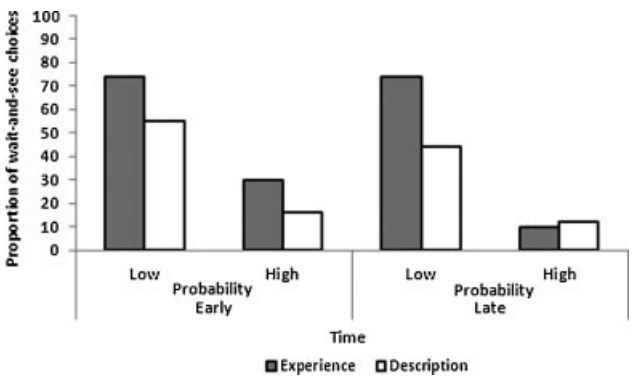

Figure 5. The proportion of final wait-and-see choices in the experience and description conditions as a function of the time (early or late) and the probability (low or high) of the occurrence of climate consequences

The small sample size in different cases, on account of the probability and the timing of the consequence, made participants observe the low probability consequence at less than its expected probability. Table 1 provides the proportion of wait-and-see choices in different cases as a function of the frequency of observing a low probability consequence as being less than or more than or equal to its expected value. The expected value is determined by the product of "*n*," the number of samples of the wait-and-see alternative performed by a participant in a case and "*p*," the true probability of observing a low probability consequence in the case. The table shows these percentages for different problem cases, where the monetary consequences, the probability of the non-zero wait-and-see consequence, and the low probability of the wait-and-see consequence are clearly labeled. When the probability of the consequence was low, there was a clear evidence of people behaving as if the low probability consequence had less impact than it deserved according to its objective probability (irrespective of the timing): The proportion of wait-and-see choices, where the low probability was encountered less frequently than expected, was greater than the proportion of wait-and-see choice, where the low probability was encountered as or more frequently than expected ($78\% >> 40\%$ and $81\% >> 29\%$). However, the proportion of wait-and-see choices, where the high probability was encountered less frequently than expected, was not consistently greater than the proportion of wait-and-see choices, where the high probability was encountered as or more frequently than expected ($32\% > 17\%$ and $8\% < 100\%$). This observation is an explanation for a significantly greater proportion of wait-and-see choices in the experience

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Table 1. The proportion of wait-and-see choices with a low probability consequence as a function of the frequency of occurrence of the low probability consequence

Cases		Problems		Low probability consequence	Proportion of wait-and-see choice (with low probability consequences)	
N	P	Wait-and-see choice	Act-now choice		# $< np$[a] %	# $\geq np$[b] %
Early	Low	\$18,000; 0.05	\$1,400; 1.0	\$18,000; 0.05	78 (35/45)[c]	40 (02/05)
Early	High	\$18,000; 0.95	\$1,400; 1.0	\$0; 0.05	32 (14/44)	17 (01/06)
Late	Low	\$340,000; 0.05	\$1,400; 1.0	\$340,000; 0.05	81 (35/43)	29 (02/07)
Late	High	\$340,000; 0.95	\$1,400; 1.0	\$0; 0.05	08 (04/49)	100 (01/01)

[a]Proportion of wait-and-see choice with a low probability consequence, where the low probability consequence was encountered less frequently than expected, i.e., n^*p, where n is the number of samples of the wait-and-see choice performed by a participant and p is the probability of the occurrence of the low probability consequence.
[b]Proportion of wait-and-see choice with a low probability consequence, where the low probability consequence was encountered as or more frequently than expected.
[c]Numbers in brackets refer to the actual frequencies of different proportions.

condition when the probability was low, and a significantly smaller proportion of wait-and-see choices in the experience condition when the probability was high (see Figure 5).

DISCUSSION

This research contributes to a better understanding of people's decisions to wait-and-see rather than act-now in a climate problem. We demonstrate that people's support to delay actions to mitigate climate change is largely influenced by the probability of the occurrence of future climate consequences and not by the timing of those occurrences. Further, the decision to choose wait-and-see is influenced by people's experience and exposure to the probability of climate consequences, regardless of its timing.

In general, we find a greater proportion of wait-and-see choices when decisions are made from experience rather than from a written description (H1). In a related research, Dutt and Gonzalez (2010) found that when people are exposed to certain negative experiences and realistic consequences of climate change in a simulation, they reduced the proportion of wait-and-see decisions in a follow-up judgment task compared to participants without the experience in the simulation. The experience gained in the simulation was immediate and certain, because participants were given a constant CO_2 goal value to maintain by manipulating their yearly CO_2 emissions and absorption. In contrast, in this study, participants were exposed to future climate consequences that were both probabilistic and uncertain in the timing of their occurrence. Thus, a participant might have to either pay a carbon-tax sometime in the future or no tax at all, where the tax magnitude and time delay were determined by the underlying probability and timing of the consequences. Therefore, results in this study agree with the observations of Dutt and Gonzalez (2010), that experience is a double-edged sword: A certain and more immediate experience reduces people's wait-and-see choices, whereas an uncertain and delayed experience increases their wait-and-see choices for climate.

This research also extends the main findings on decisions from experience and description by analyzing the combined effects of probability and time together. We find that the difference in wait-and-see choices between the low probability and high probability consequences is significantly greater when participants experience the climate consequences than when participants read about the low and high probability climate consequences as a written description (H2).

While making decisions from experience, people behave as if the low probability consequences have less impact than they deserve, according to its objective probabilities, and the high probability consequences have more impact than they deserve, according to their objective probabilities (see Table 1). In contrast, while making decisions from description, people behave as if the high probability consequences have less impact than they deserve, according to its objective probabilities, and the low probability consequences have more impact than they deserve, according to their objective probabilities. This result of less impact of the low probability consequences in experience may be explained further by the known small-sampling effect (Hertwig et al., 2004). In experience, when the probability of a consequence is low, people encounter that low probability consequence less frequently than expected due to their small sampling of the two alternatives, as was found in our results (also see Table 1).

However, when the probabilities and consequences are described rather than experienced, the difference between the low and high probability events is smaller than that in experience. This finding is consistent with the predictions of prospect theory (Kahneman & Tversky, 1979). According to prospect theory, in decisions from description, people behave as if a low probability consequence has more impact than it deserves, according to its objective probability, and a high probability consequence has less impact than it deserves, according to its objective probability. Although in our results, the predictions from prospect theory explain the reduction in the difference in the proportion of wait-and-see choices in description between the low probability and high probability, the difference does not disappear. Thus, we still

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find that a significantly greater proportion of people choosing to wait-and-see for the low probability than the high probability in description. One possible reason for this observation could be that the carbon-tax amounts used in the study are different and significantly greater than those that have been used in past studies (Hau et al., 2008; Hertwig, in press; Hertwig & Erev, 2009; Hertwig et al., 2004; Kahneman & Tversky, 1979; Weber et al., 2004) that have documented the results of people's risk preferences in decisions from description.

Furthermore, we find there was no significant difference in the proportion of wait-and-see choices between times that were early or late, when participants experienced or read descriptions of carbon-tax consequences. This finding is the most surprising and unexpected given that people would tend to adopt a wait-and-see approach because the detrimental consequences are expected to happen in the distant future and not in the present. One explanation is that the timing is observed by people in the study as something that creates a wait and thus a cost. However, in the real world, the time delay might not necessarily be perceived as a cost (because when people decide to wait in the real world, they might spend that waiting time in more productive activities). The support for this observation comes from the fact that the time, early and late, did influence the number of samples people made of the wait-and-see alternative (on account of the late time being perceived by people as costly). However, another explanation for the lack of difference could also be that the early and late times were not salient enough in the study. The lack of saliency could be due to an enormously scaled-down version of the ''real experience,'' where 1 year corresponded to a 1-second of real-time delay in experience and no time delay in description. Although there was no difference in the proportion of wait-and-see choices between times that were early or late, our findings do support those by Madden et al. (2003), who found that although there were significant differences in choices for delayed and immediate rewards (unlike us); the direction of the difference was the same when the time was either experienced or described. We plan to do follow-up studies to test the effects of early and late time after we have taken into account the above listed factors that could potentially be reasons for the lack of difference.

In the past, the JDM literature has documented the individual effects of the probability and timing of consequences on people's risk- and time-preferences, respectively. However, we know little about how choices are influenced by the experience and description of both the timing and the probability of the consequences. Our findings indicate that people's wait-and-see choices for climate are influenced primarily by their perception of the probability of climate consequences. Thus, a person's choice to wait-and-see is governed by a low or high probability of future climate consequence. A low probability has a moderating effect in the presentation of high taxes in the case of an early or late timing of a consequence: an early or late time makes the magnitude of carbon-tax high; however, a low probability makes a high tax-consequence rare. This explanation is confirmed by the fact that the difference in the proportion of wait-and-see choices disappeared when an early or late timing of climate consequence incurred a large tax that occurred with a high probability, in which case, very few people chose the wait-and-see alternative.

We presented people with consequences of future climate change as carbon taxes. This is, of course, legitimate and also makes experimentation easier as different alternatives can easily be compared by participants. However, we believe that there are other ways of simulating people's imagination and giving people experiences of climate consequences that are different from tax payments. For example, in the past, Dutt & Gonzalez (2009) have given participants experiences of climate change by showing them the effects of the CO_2 emissions on the CO_2 concentration levels. Furthermore, Dutt and Gonzalez (2009) associated the increases in the CO_2 concentration levels above a pre-define goal with a corresponding increase in temperature and sea level rise in the world. Similarly, some other means of providing climate experiences could be in the form of pictures of objects that participants associate with (e.g., a house one would live-in, which is close to a sea coast), and how those objects might be affected by climate change (e.g., severe waves and winds due to future climate change).

Finally, one might argue that it is possible that the likelihood of climate change is currently high, but the probability that specific intervention and/or research programs are cost effective, is low. It is to be noted that the carbon tax consequences that people faced in different problems in the study included both costs of damages due to future climate change as well as *costs of abatement* of climate change (the latter cost forms a part of the cost of different interventions). Thus, another possible explanation of a greater wait-and-see in experience compared to description could be that our experience with climate interventions can reduce our tendency to invest in addressing climate change because these interventions are perceived as costly. Also, as observed in our results, one might show more support for the wait-and-see alternative after costly experiences of an intervention. However, one should also acknowledge that currently we do not know whether the probability associated with future climate change, or whether the probability of the cost-effectiveness of its interventions *in the future* will be low or high. Thus, in the study, we assumed both possibilities, i.e., when the probability is *low* in the future and when the probability is *high* in the future. Although in the study, we provided tax consequences that were detached from a particular climate intervention, it will be interesting to test whether the experience of one of the intervention programs (e.g., switching off lights in one's home for 1 hour in the evening) could reduce our tendency to invest in addressing the climate change issue due to it being costly and due to the probability of the intervention's cost-effectiveness being low currently, and it being low or high in the future.

Contributions of the study to judgment and decision making

Unlike previous studies on decisions from experience and description, where only the probability of the risky outcomes was manipulated, we manipulate both the probability and

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timing in a problem involving a binary-choice in conditions of experience and description in this study. This unique manipulation allows us to experiment with a practical problem with distinctive characteristics like climate, where the consequences are both probabilistic and delayed in time, and to measure how these factors interact together to influence people's wait-and-see choices. Although this study applied JDM principles to people's wait-and-see behavior on climate, similar applicative contributions of decisions from experience and description paradigms have been made in other practical problems. For example, Shafir, Reich, Tsur, Erev, and Lotem (2008) have demonstrated the certainty effect in descriptive-based and reversed-certainty effect in experience-based choice both for bumble bees as well as humans. Similarly, Yechiam, Barron, and Erev (2005) have demonstrated that the risk sensitivity of local Israeli residents differ from those of the international tourists on account of their personal experiences. Yechiam et al. (2005) have reported similar findings in a laboratory experiment involving a binary-choice problem.

We believe that the distinctive characteristics of the climate problem make it both interesting and challenging to apply the theories and methods of JDM research. Thus, unlike other problems, the climate problem is naturally suited to and allows us to test the joint effects of the probability and timing of consequences in a single problem on people's wait-and-see choices.

Implications of the findings to policy

There is little scientific doubt that climate change will occur if we continue on a path of increasing greenhouse gas emissions (IPCC, 2007). According to Weber (2006), an act-now approach could be adopted if the consequences due to climate change could arouse visceral reactions of fear in the minds of the general public. One method for doing so is to provide climate consequences that are either descriptive or experiential. The descriptive information could appear using letters and numbers, whereas the experiential information could form a part of a figure or imagery (i.e., through commercials and movies like *An Inconvenient Truth* or *The Day After Tomorrow*) (Leiserowitz, 2004) or a dynamic simulation (Dutt & Gonzalez, 2010). Our results show that people like to act-now when they either experience or read a written description of climate consequences that communicates a high probability of climate consequences occurring in the future. Thus, based upon our results, one way to evoke visceral reactions of fear or a conscious awakening is to present people with descriptions and experiences of future climate consequences that make them perceive these consequences as occurring with a high probability in the future. In fact, Leiserowitz (2004) found that a greater proportion of people who watched the movie, *The Day After Tomorrow*, wanted to act now on the climate problem than those who did not watch the movie. Future research that applies JDM principles on climate change would benefit by building upon the findings of this study.

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REFERENCES

Ainslie, G. (1975). Specious reward: A behavioral theory of impulsiveness and impulse control. *Psychological Bulletin*, *82*, 463–496. DOI: 10.1037/h0076860

APA. (2009). Psychology and global climate change: Addressing a multi-faceted phenomenon and set of challenges. Retrieved from http://www.apa.org/science/climate-change/

Barron, G., & Erev, I. (2003). Small feedback-based decisions and their limited correspondence to description-based decisions. *Journal of Behavioral Decision Making*, *16*, 215–233. DOI: 10.1002/bdm.443

Benzion, U., Rapoport, A., & Yagil, J. (1989). Discount rates inferred from decisions: An experimental study. *Management Science*, *35*, 270–284. DOI: 10.1287/mnsc.35.3.270

Cohen, M., Jaffray, J. Y., & Said, T. (1987). Experimental comparison of individual behavior under risk and under uncertainty for gains and for losses. *Organizational Behavior and Human Decision Processes*, *39*, 1–22. DOI: 10.1016/0749-5978(87)90043-4

Condon, S. (2010). Conservatives use ''Snowmageddon'' to mock global warming. *CBS News.* Retrieved from http://www.cbsnews.com/8301-5035 44_162-6194071-503544.html

Dutt, V., & Gonzalez, C. (2009). Human control of climate. Manuscript submitted for publication.

Dutt, V., & Gonzalez, C. (2010). Decisions from experience reduces ''wait-and-see'' behavior in climate change. Manuscript submitted for publication.

Feldman, S. (2010). EU Climate Chief: U.S. climate law needed for global deal [Blog post]. Retrieved from http://solveclimate.com/blog/20100511/eu-climate-chief-u-s-climate-law-needed-global-deal

Fishburn, P. C., & Kochenberger, G. A. (1979). Two- piece von Neumann- Morgenstern utility functions. *Decision Sciences*, *10*, 503–518. DOI: 10.1111/j.1540-5915.1979.tb00043.x

Gonzalez, C., & Dutt, V. (2010). Instance-based learning model: Integrating sampling and repeated choice paradigms. Manuscript submitted for publication.

Gottlieb, D. A., Weiss, T., & Chapman, G. B. (2007). The format in which uncertainty information is presented affects decision biases. *Psychological Science*, *15*, 240–246. DOI: 10.1111/j.1467-9280.2007.01883.x

Hau, R., Pleskac, T. J., Kiefer, J., & Hertwig, R. (2008). The description–experience gap in risky choice: The role of sample size and experienced probabilities. *Journal of Behavioral Decision Making*, *21*, 493–518. DOI: 10.1002/bdm.598

Hershey, J. C., & Schoemaker, P. J. H. (1980). Risk taking and problem context in the domain of losses: An expected utility analysis. *Journal of Risk and Insurance*, *47*, 111–132. Retrieved from http://www.jstor.org/stable/pdfplus/252685.pdf?acceptTC=true

Hertwig, R. (in press). The psychology and rationality of decisions from experience. *Synthese.*

Hertwig, R., Barron, G., Weber, E. U., & Erev, I. (2004). Decisions from experience and the effect of rare events in risky choice. *Psychological Science*, *15*(8), 534–539. DOI: 10.1111/j.0956-7976.2004.00715.x

Hertwig, R., & Erev, I. (2009). The description-experience gap in risky choice. *Trends in Cognitive Sciences*, *13*, 517–523. DOI: 10.1016/j.tics.2009.09.004

IPCC. (2007). Climate change 2007: Synthesis report. In R. K. Pachauri, & A. Reisinger (Eds.), *Contribution of working groups I, II and III to the fourth assessment report of the intergovernmental panel on climate change* (pp. 1–104). Geneva, Switzerland: IPCC.

Jones, A. (2002). We can't afford to "wait-and-see" on climate change [online article]. Retrieved from http://www.sustainer.org/pubs/columns/07.19.02Jones.html

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*, 263–291. DOI: 10.1234/12345678

Leiserowitz, A. (2004). Before and after The Day After Tomorrow: A U.S. study of climate change risk perception. *Environment*, *46*(9), 22–37.

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change*, *77*, 45–72. DOI: 10.1007/s10584-006-9059-9

Leiserowitz, A. (2007). International public opinion, perception, and understanding of global climate change. In *Human Development Report 2007/2008*, United Nations Development Program.

Lejarraga, T. (2010). When experience is better than description: Time delays and complexity. *Journal of Behavioral Decision Making*, *23*(1), 100–116. DOI: 10.1002/bdm.666

Lejarraga, T., Dutt, V., & Gonzalez, C. (in press). Instance-based learning: A general model of decisions from experience. *Journal of Behavioral Decision Making.*

Loewenstein, G., & Elster, J. (1992). *Choice over time*. New York: Russell Sage.

Madden, G. J., Begotka, A. M., Raiff, B. R., & Kastern, L. L. (2003). Delay discounting of real and hypothetical rewards. *Experimental and Clinical Psychopharmacology*, *11*, 139–145. DOI: 10.1037/1064-1297.11.2.139

McClure, S. M., Ericson, K. A., Laibson, D. I., Loewenstein, G., & Cohen, J. D. (2007). Time discounting for primary rewards. *The Journal of Neuroscience*, *27*, 5796–5804. DOI: 10.1523/JNEUROSCI.4246-06.2007

Nordhaus, W. (1994). Expert opinion on climatic change. *American Scientist*, *82*, 45–51. Retrieved from http://stephenschneider.stanford.edu/Publications/PDF_Papers/NordhausSM.pdf

Nordhaus, W. (2008). *A question of balance*. New Haven, CT: Yale University Press.

Rahmstorf, S. (2008). A semi-empirical approach to projecting future sea-level rise. *Science*, *315*, 368–370. DOI: 10.1126/science.1135456

Rakow, T., Demes, K., & Newell, B. (2008). Biased samples not mode of presentation: Reexamining the apparent underweighting of rare events in experience-based choice. *Organizational Behavior and Human Decision Processes*, *106*, 168–179. DOI: 10.1016/j.obhdp.2008.02.001

Shafir, S., Reich, T., Tsur, E., Erev, I., & Lotem, A. (2008). Perceptual accuracy and conflicting effects of certainty on risk-taking behavior. *Nature*, *453*, 917–920. DOI: 10.1038/nature06841

Sterman, J. D. (2008). Risk communication on climate change: Mental models and mass balance. *Science*, *322*, 532–533. DOI: 10.1126/science.1162574

Sterman, J. D., & Booth Sweeney, L. (2002). Cloudy skies: Assessing public understanding of global warming. *System Dynamics Review*, *18*, 207–240. DOI: 10.1002/sdr.242

Sterman, J. D., & Booth Sweeney, L. (2007). Understanding public complacency about climate change: Adults' mental models of climate change violate conservation of matter. *Climatic Change*, *80*, 213–238. DOI: 10.1007/s10584-006-9107-5

Stern, N. (2006). Stern review report in the economics of climate change. Retrieved from http://www.hm-treasury.gov.uk/sternreview_index.htm

Thaler, R. H. (1981). Some empirical evidence on dynamic inconsistency. *Economics Letters*, *8*, 201–207. DOI: 10.1016/0165-1765(81)90067-7

The Economist. (2010). The clouds of unknowing. *The Economist.* Retrieved from http://www.economist.com/node/15719298?story_id=15719298

Tversky, A., & Fox, C. R. (1995). Weighing risk and uncertainty. *Psychological Review*, *102*, 269–283. DOI: 10.1037/0033-295X.102.2.269

Tversky, A., & Kahneman, D. (1992). Rational choice and the framing of decisions. *The Journal of Business*, *59*, 251–278. DOI: 10.1234/12345678

Ungemach, C., Chater, N., & Stewart, N. (2009). Are probabilities overweighted or underweighted, when rare outcomes are experienced (rarely)? *Psychological Science*, *20*, 473–479. DOI: 10.1111/j.1467-9280.2009.02319.x

Vidal, J., & Adam, D. (2007). China overtakes US as world's biggest CO2 emitter. The Guardian. Retrieved from http://www.guardian.co.uk/environment/2007/jun/19/china.usnews

Weber, E. U. (2006). Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Climatic Change*, *77*, 103–120. DOI: 10.1007/s10584-006-9060-3

Weber, E. U., Shafir, S., & Blais, A.-R. (2004). Predicting risk sensitivity in humans and lower animals: Risk as variance or coefficient of variation. *Psychological Review*, *111*, 430–445. DOI: 10.1037/0033-295X.111.2.430

Yechiam, E., Barron, G., & Erev, I. (2005). The role of personal experience in contributing to different patterns of response to rare terrorist attacks. *Journal of Conflict Resolution*, *49*, 430–439. DOI: 10.1177/0022002704270847

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