Evaluation of uncertain climate change information

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Sundblad, E-L. Evaluation of uncertain climate change information. Göteborg Psychological Reports, 2008, 38 No 2. Scientific uncertainty is a common characteristic of information about new research findings. Since people generally dislike uncertainty, uncertain events can be evaluated as worse than if they happen for certain, an uncertainty effect (Gneezy, List & Wu, 2006). Two studies assessed risk perception of scientifically uncertain climate change consequence. Participants, in Study 1 (N = 64) were either informed of a 50 % probability or a 100 % probability that some specific events would occur or that they occur with 100 % probability. Unexpectedly, these events were perceived as less risky in the 50 %-probability, than the 100 %-probability condition. In Study 2, other participants (N = 30) met a more elaborate test procedure. Increased risk perception was revealed for those informed of a 50 % probability as compared with a 100 % probability (although not statistically significant). The results of the two studies indicate that an uncertainty effect is dependent on elaborated mental processing.

Key words: scientific uncertainty, uncertainty effect, climate change consequences

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Many of the statements presented by the United Nation’s Intergovernmental Panel of Climate Change (IPCC) are validated by a confidence level. One example is that “most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations” (p. 8, IPCC, 2007a). The expression “very likely” is defined by IPCC to express a larger than 90% probability. Other statements that also are likely, although not certain, are future consequences such as disturbance of ecosystems, food production and negative health effects (IPCC, 2007b). The (un)certainty may influence the evaluation of the event compared with if the statement was certain. It is reasonable to expect that 100% probability of a negative event is evaluated as worse than if the event is believed to occur with, for example, a 50% probability. However, this may not always be the case.

Previous research has revealed that limited certainty, in the form of a lottery, can cause evaluations that are less than optimal (Gneezy, List, & Wu, 2006). A tendency to discount the uncertain option is proposed to lead to behaviour that can be regarded as overreactions compared with if the event was evaluated by its expected utility.

One anomaly regarding uncertainty is that people value a lottery ticket less than the lottery’s worst outcome. This is called the uncertainty effect (Gneezy et al. 2006). The uncertainty effect has been exemplified in an experiment comparing a sure thing condition with a lottery condition. On average, participants were willing to pay $38 for a $50 gift certificate (sure thing), while they only were prepared to pay $28 for a lottery ticket that gave a 50% chance of winning a $50 gift certificate, or a 50% chance of winning a $100 gift certificate (uncertain thing). The uncertainty effect violates an axiom of standard decision theory since the value of a risky prospect ought to lie between the value of the highest and
lowest outcome of that prospect. The effect is also a violation of a non-expected utility theory such as prospect theory.

The uncertainty effect for lotteries has been detected both in single evaluation mode (SE) and when two stimuli are compared simultaneously, joint-evaluation mode (JE). Other research has shown that evaluation mode normally is important for the result, as evaluations made in SE mode are less sensitive to magnitude. People in SE mode are generally able to tell whether a value is good or bad but are unable to tell exactly how good or how bad it is (Hsee, Rottenstreich & Xiao, 2005). However, in this respect the uncertainty effect has been proven to be robust.

According to Gneezy et al. (2006) there are two necessary conditions for the uncertainty effect. One condition is that an internal strive for consistency is opposed. The effect has been tested in between-subject designs. The other condition is that participants translate the values that are involved. In the lottery there is supposed to be a process in which participants first code the options and then value them. In the SE mode, values of gift certificates were translated to monetary value. For example, the $50 gift certificate may be valued as a $38 option, and the lottery between a $50 gift certificate and a $100 gift certificate may be recoded into a $75 gift certificate plus some risk, assigned a value of $50. To account for uncertainty, this amount is reduced to $28, which is inferior to the $38 option. The translation is suggested to reduce consistence transparency and increase the cognitive workload.

We propose that the uncertainty effect will also pertain to information about scientific uncertainty. Thus, events that are expected to occur with less certainty may be evaluated as worse than if the negative events are certain. For example, a 50% probability for a negative climate consequence is in a first step coded as somewhat better than a certain consequence, although still interpreted as risky. In the next step, the evaluation is recoded into a more negative value due to the uncertainty. In that case, climate change consequences that are
predicted to happen with 50% probability be regarded as worse than if they will happen with 100% probability. If an uncertainty effect is evoked by the existence of certainty information, the intended message may consequently elicit worry and its purpose may be misdirected.

Emotional and cognitive risk perception (worry and probability) are relevant as dependent variables (Sundblad, Biel & Gärling, 2007). So is the severity of damage (Peters & Slovic, 1996). However, as the experimental conditions explicitly inform of scientific probabilities, this measure is not relevant here. Another complication is that the task to evaluate perception of worry may not be easy for anyone in the SE mode. It is hardly something people quantify in their daily life. On the other hand, we suggest that severity of damage is easier to estimate.

Gneezy et al. (2006) proposed that the translation procedure is necessary to cause mental workload and hinder transparency. For example, the value of a gift certificate will be translated into its monetary equivalent. In the current studies, we examine the uncertainty effect in a new domain. Here, we suggest that the mental obstacles that are involved in evaluating risk may create the necessary work load. Perception of risk is a process that incorporates both cognitive and emotional assessments (Lowenstein, Weber, Hsee, & Welch, 2001), which may be involved in translation work. In addition, worry is a combination of several factors (Peters & Slovic, 1996). We also suggest that the complicated character of the consequences cause workload that influences the evaluation procedure. Climate change consequences are multi-dimensional. Consequently, we start to test risk perception of the consequences with two measures relevant for risk perception and suggest that cognitive workload will be at hand.

In sum, evaluations of climate change consequences that are affected by the uncertainty effect are expected to be more negatively evaluated compared with evaluations that are in line with the expected utility theory. Thus, the uncertainty effect may be important for how information from IPCC regarding climate change consequences is interpreted. This article
contributes to knowledge of effects from information by testing evaluations of environmental consequences with dependent variables that are valid in the environmental domain.

In Study 1 we investigated if there is an uncertainty effect for the evaluation of climate change consequences under scientific uncertainty by assessing two evaluation components; severity of damage and worry. In Study 2, we altered the test conditions to increase workload.

Study 1

In Study 1 we tested whether both severity of damage and worry are conceived of as more negative for groups informed of a 50 % probability for consequences compared with consequences occurring with a 100 % probability.

Method

Participants. Sixty-four university students (52 women, mean age = 32.7 years) participated. The participants were approached at the end of a lecture and asked to volunteer in return for a lottery ticket worth SEK 25 (approximately EUR 2.7).

Procedure. Each participant was randomly assigned to one of two certainty conditions. One condition informed that a consequence would happen with a 50 % probability, the other condition that it would occur with 100 % probability. A booklet was administered to the participants in a lecture room. Four consequences selected from an IPCC report (2007 b) (see Appendix) were presented in the booklet. The participants assessed damage severity for the four consequences on one page, and estimated worry when thinking of these consequences on another page. The order between worry and damage questions were counterbalanced within the groups. The ratings were made on 11 point scales with verbally defined end alternatives. The damage scale ranged from 1 (no big damage) to 11 (extremely big damage), and the
worry scale from 1 (absolutely not worried) to 11 (very worried). Finally, participants answered questions about gender and age.

**Result**

To detect an uncertainty effect the 50 % probability group was compared with the 100 % probability group. The group that was informed of a 50 % probability estimated less severity of damage (M = 8.3, SD = 2.4) than the group informed of a 100 % probability (M = 8.8, SD = 1.8). A 2 (group) x 4 (consequence) mixed factorial ANOVA with repeated measures on the last factor did not reveal a significant main effect, $F (1, 62) < 1$. There was a significant main effect of consequence, $F (3,186) = 3.88, p = .01$, but there was no interaction effect with group, $F (3,186) = 1.19, p = .31$.

Worry was also slightly lower for the group informed of a 50 % probability (M = 6.9, SD = 2.6) than the group informed of a 100 % probability (M = 7.7, SD = 1.9). A parallel ANOVA on worry did not yield a significant effect of uncertainty, $F (1, 62) = 2.36, p = .13$. As for severity damage, there was a significant main effect of consequence, $F (3,186) = 2.90, p = .04$, but no interaction effect, $F (3,186) = 1.20, p = .31$.

**Discussion**

Study 1 revealed lower levels of estimated severity of damage and worry for a 50 % probability compared with a 100 % probability. Hence, there was no uncertainty effect. In fact, risk perception was lower for uncertain outcomes compared with certain outcomes.

The conditions necessary to reveal an uncertainty effect are claimed to be between-subjects designs as well as a translations process to avoid internality strives and increase workload. The original condition of a translation process for the uncertainty effect to materialize was not possible to copy exactly in this study. Gneezy et al. (2006) specified two necessary conditions. One was to avoid transparency and the other was to increase cognitive demand. It is a possibility that in the present study that the conditions of avoidance of
transparency was not met and also that cognitive demand was not sufficient. We argue that since the climate consequences are complex, there is little risk for transparency. On the other hand, the prerequisite of cognitive workload is more unclear. To increase mental workload and initiate a translation process we introduced another procedure in Study 2. Primarily, we wished to increase the likelihood that participants considered the climate consequences more carefully.

Study 2

In Study 2, we first introduced participants to effects of their own present behaviour. We believe that this procedure made the second phase, evaluation of climate consequences in the questionnaire, less abstract and invited participants to evaluate them in the light of effects from human behaviour.

Method

Participants. Thirty current and former university students (20 women, mean age = 30.1) participated in compensation for a free cinema ticket. They were recruited through sign-up sheets and electronic mails.

Procedure. Each participant was randomly assigned to one of two conditions, with the number of women and men held approximately constant between conditions. The participants were explicitly guaranteed to be anonymous. They were seated in front of computers in the laboratory and performed two tasks. The first task aimed to introduce the participant to the field of study and to bring about a personal involvement. The participants completed a computer-aided calculation of their own current emission of carbon dioxide, which took approximately 10-15 minutes. The computer program was set up by the environmental committee of Göteborg municipality and is available as an internet service to local citizens. In
the second task, a questionnaire was administered. The questionnaire started with basic information about climate change, as well as a brief description of the same four severe negative consequences as in Study 1 (reproduced in Table 1). All consequences were selected from an IPCC report (2007b). We varied to what extent scientists were certain that these consequences would occur. One of the groups was informed that the consequences would occur with a 50 % probability and the other group with a 100 % probability. All participants were asked to rate severity of damage, “How severe damage will following consequence cause assumed they happen within 100 years?”, and degree of worry, “To which extent are you worried when thinking about that climate change causes the following consequences within 100 years?”. Each consequence was rated on 11-point scales with verbally defined end points. The damage scale ranged from 1 (no big damage) to 11 (extremely big damage), and the worry scale from 1 (absolutely not worried) to 11 (very worried). Finally, participants completed demographic questions.

Results

Severity of damage. The evaluation of each consequence differed between the groups (see Table 1). On average, the 50 %-probability group expected more severe damages (M = 9.1, SD = 1.6) than the 100 %-probability group did (M = 8.3, SD = 2.1). A 2 (probability: 50 % vs. 100 %) by 4 (consequences) ANOVA with repeated measures on the least factor did not yield a significant effect of uncertainty, $F (1,28) < 1$, but a significant main effect of consequence, $F (3, 84) = 5.22, p < 0.01$. There was no interaction effect with group, $F (3, 84) = 1.33, p = .27$.

Another way to analyze the results is to compare them with expected utility. The group informed about 50 % certainty may have inferred that the event will either happen or not, with the same probability. Hence, with an evaluation in line with the expected utility the damage severity for the 50 %-probability group would have been approximately half of that of the 100
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%-probability group. This was clearly not the case as the 50 %-probability group had the highest severity scores.

Worry. The feeling of worry among the two groups for each of the four consequences varied slightly, as shown in Table 1. All four consequences were perceived as more worrying for the 50 %-probability group compared with the 100 %-group. On average, the 50 %-probability group was more worried (M = 9.3, SD = 1.8) compared with the 100 %-probability group (M = 7.7, SD = 3.2). A parallel ANOVA on worry did not show a significant main effect of uncertainty, $F(1, 28) = 2.86, p = .10$, nor a significant main effect of consequences, $F(3, 84) = 1.92, p = .13$. No significant interaction effect with group was revealed, $F(3, 84) = 1.58, p = 0.20$.

Discussion

Study 2 revealed higher estimates of severity of damage and perceived worry of environmental consequences for a 50 % probability compared with a 100 % probability. The results are consistent with an uncertainty effect and violate expected utility theory since the theory requires that the value of a risky prospect lies between the value of the highest and the lowest outcome of that prospect. Still, the cause of these differences may differ between the two dependent variables.

The evaluations of damaging effects were slightly higher for a lower probability of the consequences. All participants were faced with the same consequences. In order to evaluate how damaging these consequences are, participants have to transform them into consequences for the environment or for humans. This elaboration corresponds to the translations phase as suggested by Gneezy et al. (2006). Then, these translated consequences are valued. The negative value put on these consequences may be somewhat lower in an uncertain than a certain condition. However, in the uncertain condition there is also an effect of risk aversion. Taken together, the effect of the consequence and the effect of risk aversion in the 50 %-
probability condition is larger than the effect of the same consequence in the 100-% probability condition.

The higher level of worry for the group informed about a 50 % probability has several possible explanations. First, worry may be a combination of worry due to the event and worry due to the existence of uncertainty. This is in line with Peters and Slovic’s (1996) conclusion that psychological dimensions of risk are based on dread or on risk of the unknown. Most uncertainty was introduced in the 50 %-probability group. Hence, participants in this group may have been more worried than participants in the other two groups. The level of dread is equal for the three groups. The result is also consistent with an evaluation of a risky prospect in two phases as suggested by Gneezy et al. (2006). In the first phase, there is an estimate of worry for the event although still regarded as risky. In the second phase, the estimated value is affected by worry due to uncertainty. Since only the 50 %-probability group is affected by the worry associated with uncertainty, this group would be more worried.

A second explanation is that lack of information causes a penalty effect. The penalty effect is a discount of the evaluation due to lack of important information (Ebenbach & Moore, 2000). This may explain the more unfavourable result for the 50 %-probability group than for the 100 %-group. A penalty effect would be revealed in comparing a group with missing information and a group who receives information about all alternative outcomes.

Finally, common for both dependent variables was that the 50 %-probability group showed higher risk perception than the 100 %-probability group. To assess these differences the measures that are used must be evaluable. Gneezy et al. (2006) used dependent variables that altered from money to devotion of own time. These measures have standardized scales that people are accustomed to use. Moreover, if it is possible to bring to mind a range, an average value, or some reference point, the evaluability is facilitated and increased (Hsee et al., 2005). In contrast, the current study used worry as one of its measures. People may not be
accustomed to evaluate their degree of worry. However, the similarity in tendency for severity of damage and worry counters the possibility that a lack of evaluability for worry had an important effect on the result.

General Discussion

Previous research has demonstrated an uncertainty effect for lotteries (Gneezy et al., 2006), implying a higher risk perception for events that are uncertain than if they are certain. This uncertainty effect may be extended to consequences of the climate change. While the results of Study 1 did not show an uncertainty effect, the results of Study 2 suggested such an effect, albeit not statistically significant.

The probability characteristics of a lottery are similar to information of probabilities of climate change consequences. Hence, the effect could exist in both domains. On the other hand, there are also at least two differences between the domains. Lotteries constitute a pure random process. This is not the case for climate consequences. Another difference is the value of the outcomes. Lotteries have positive outcomes while climate change consequences are negative.

There are also differences in test conditions between the present studies and those by Gneezy et al. (2006). We used risk perception as dependent variables rather than money or choices between financial alternatives. The importance of this fact is difficult to evaluate. As mentioned earlier we do not believe that reduced evaluability has prevented the uncertainty effect to manifest itself. The necessary condition to avoid transparency in tests of internality axiom, and the translation between currencies, were not possible to replicate exactly. Instead, in both studies other means were used to increase workload. One mean was the complexity of climate change consequences. Another mean, used in Study 2, was a more elaborated
procedure. This procedure invited participants to associate climate consequences of their own present behaviour with the climate consequences presented in the questionnaire. Hence, we suggest that realistic setting of scientific uncertainty may cause other effects than more abstract and heuristic evaluations.

Even though Gneezy et al. (2006) revealed an uncertainty effect in lotteries, it is valuable to know if this effect exists also for uncertain events in other domains. To say the least, this is due for information about climate change. This information is intended to increase people’s knowledge, but also to influence decision making and behaviour in a proenvironmental direction. The probabilistic nature of such information warrants further investigation of its intended, or unintended, effects.

References


Table 1

Mean (SD) assessment of worry and severity of damage reported by groups informed about a 50 or a 100 % scientific certainty of consequences

<table>
<thead>
<tr>
<th>Consequences</th>
<th>Worry</th>
<th>Damage</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some local glaciers have melted completely</td>
<td>9.7</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>(2.1)</td>
<td>(3.4)</td>
</tr>
<tr>
<td>Food production will decrease with up to 50% in Africa, resulting in hunger</td>
<td>9.9</td>
<td>8.0</td>
</tr>
<tr>
<td>and starvation</td>
<td>(2.3)</td>
<td>(3.7)</td>
</tr>
<tr>
<td>Recurring long heat waves in Southern Europe and North America</td>
<td>9.3</td>
<td>7.5</td>
</tr>
<tr>
<td>constitute severe health risks for infants and elderly</td>
<td>(1.9)</td>
<td>(3.3)</td>
</tr>
<tr>
<td>An increased water level of oceans makes approximately 20 small island</td>
<td>8.5</td>
<td>7.7</td>
</tr>
<tr>
<td>countries impossible to live in</td>
<td>(3.1)</td>
<td>(3.1)</td>
</tr>
</tbody>
</table>
Text of consequences used for 50 % and for 100 % certainty:

A. There is a x % probability that some local glaciers have melted completely

B. There is a x % probability that food production in Africa will decrease to half of current level resulting in hunger and starvation

C. There is a x % probability that recurring long heat waves in Southern Europe and North America constitute severe health risks for infants and the elderly

D. There is a x % probability that a rise in sea-level makes approximately 20 small island countries impossible to live in

(translated from Swedish)