

# **People's knowledge about climate change: Uncertainty as a guide to future commitments**

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### Abstract

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Knowledge of climate change is provided by scientists to other groups in society who have to interact to establish sustainable development. Hence, the knowledge must reach people and the content must be evaluated as important and relevant. In **Study I**, knowledge and confidence in one's own knowledge was studied in a survey among four groups in society: experts, politicians, environmental journalists and laypersons. The study revealed gradually decreasing knowledge levels from experts to journalists, politicians and laypersons. The confidence levels showed a similar pattern. Both knowledge and confidence levels were higher for causes than state and consequences of climate change. All groups had less knowledge of health consequences as compared to weather and sea/glacier consequences. The realism of confidence in their own knowledge was somewhat higher among journalists than among experts, and relatively low among politicians and laypersons. **Study II** tested to what extent scientific knowledge of various domains was related to cognitive and affective risk judgements among laypersons. Subgroups divided by gender, being a parent or not, education, age and type of residence were analyzed. The results revealed that knowledge of both health consequences and causes of climate change was positively related to cognitive and affective risk judgements. Gender influenced affective but not cognitive risk judgements, as women were more worried than men. **Study III** revealed that information of scientific uncertainty of climate consequences influence risk perception. **Study IV** revealed that temporal distance to negative environmental consequences did not influence participants' intention to mitigate CO<sub>2</sub> emissions. Taken together, this research represents some steps towards a greater understanding of what facilitates and hinders the process toward a sustainable society. The studies show that scientific knowledge about climate change seems to be disseminated in an unbiased manner in society. Moreover, the results support the claim that both knowledge and confidence levels will increase when people learn more about climate change. In particular, risk awareness can be raised by increased knowledge of health consequences and of causes of climate change.

Key words: climate change knowledge, confidence in one's own knowledge, risk perception of climate change, scientific uncertainty, temporal discount

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## Acknowledgements

One can become thoughtful about the fact that we humans at times seem to act against our own will. For example, the environment is valuable and appreciated by people, nevertheless humans act in a way that destroys much of the environment. Yet we are aware of our actions. How is this possible? Four years ago I started my search for an answer. The purpose was to find out more about why people behave so inconsistently. Can people really absorb the messages about environmental problems? What support or tools can improve the situation, giving the environment and humanity a better chance for the future? The strange and wonderful world of academy and science became my world in this search. The work has opened new perspectives for me in many ways. I have received new insights into humans, cognition, climate and ecosystems. With a better understanding of the complexity involved in decision making and the limitations that influence people I am still optimistic. I think it is possible to overcome many of the obstacles to environmentally responsible behaviour. One of the keys to that is to use knowledge consciously and to keep aware of the situation.

The work has been very motivating in itself. Increasing attention from media and the public on climate change issues have also helped me to keep my focus. To an even greater degree, many persons in my vicinity have been of great value to me.

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## List of publications

This thesis consists of a summary and four papers, which are referred to by roman numerals:

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- II. Sundblad, E.-L., Biel, A., & Gärling, T. (2007). Cognitive and affective risk judgements related to climate change. *Journal of Environmental Psychology*, 27, 97-106.
- III. Sundblad, E.-L. (2008). Evaluation of uncertain climate change information. *Manuscript*.
- IV. Sundblad, E.-L., Biel, A., & Gärling, T. (2008). Timing of climate change consequences: Its effect on the intention to mitigate CO<sub>2</sub> emissions. *Manuscript submitted for publication*.

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## Introduction

Global climate change (GCC) is a phenomenon that has received increasing attention in the last decades. The attention is motivated by claims that GCC will cause enormous worldwide problems in the future, and that it constitutes a challenge for humanity to mitigate or adapt to (United Nations's Intergovernmental Panel on Climate Change [IPCC], 2007a, 2007b). Attention is also motivated by the fact that GCC is a symptom of a society that is not sustainable. However, before forceful actions toward a more sustainable society can take place, there has to be a common awareness of potential problems, at least among powerful groups. In this initial process, knowledge of GCC plays an important role. Through the development, acceptance and dissemination of knowledge, the foundation is provided for groups in society to reach a mutual understanding and motivate joint actions.

Scientists generate new findings and their knowledge advances over time. As a result, what once was nearest to the truth may later be seen as less likely. Scientific knowledge is perishable. While scientists generate new findings, society relies on people using the existing knowledge to act in the common interest. Thus, it is important for the public, as well as for scientists, that current and new knowledge is communicated. Journalists have a role in transferring the GCC information (Wilson, 2000). Unfortunately, journalists have to deal with circumstances that can be in conflict with ambitions to provide complete scientific knowledge. For example, a journalistic text has limited space available and is normally focused on news. Consequently, there are difficulties in presenting complicated issues, which opens up for the receivers of information to develop beliefs that are distorted or simplified.

Even if scientific knowledge of GCC is transferred correctly, there are subjective judgements to be made. One of these concerns the extent to which people have confidence in their own knowledge. Another judgement is whether or not the fact is regarded as a risk. Such evaluations are important for the willingness to process GCC information and to act upon climate change knowledge. A risk judgement may also raise further attention.

There are several characteristics of the information about climate change that may influence risk perception. One of these is scientific uncertainty. Hardly any scientific "fact" is 100 % certain. Another characteristic is the future orientation of climate events, for example regarding consequences of climate change. Consequences that can not yet be perceived may be regarded as being of less immediate importance. In addition, the occurrence of future events may be regarded as uncertain.

The fact that people make different judgements may originate in differences in their knowledge base, in their confidence in their own knowledge or in their reactions to information characteristics. However, even though evaluative differences exist between people, it must be of practical value that all groups in society reduce their ignorance and perception of uncertainty by acquiring valid knowledge.

The purpose of the present thesis is to look into some conditions that affect how people acquire, evaluate and use knowledge of GCC. First, I investigate whether different groups of people have accurate scientific knowledge regarding GCC, and to what extent they have a realistic picture of their own knowledge. Then I examine how knowledge of climate change influences people; to what extent are different domains of knowledge important for risk judgements? What impact does information of scientific uncertainty have on risk perception? Finally, to what extent is the delay of future consequences important for intentions to mitigate climate change?

The intention is to provide a basis for recommendations concerning the transfer of knowledge to society. A related intention is to describe how knowledge of various domains of climate change affects risk judgements among subgroups in society, as risk judgements are important in designing information campaigns. A third intention is to provide advice on how to inform the public about scientific uncertainty.

The theoretical background of the present thesis is reviewed in the following sections. A brief description of climate change is followed by relevant research regarding knowledge transfer. Theoretical reviews of confidence in beliefs and of risk judgements precede reviews of the uncertainty concept, and how uncertainty as well as time delay of future events may affect judgement and decision making. The background concludes with theories that concern the link between knowledge and behavioural intentions. After a summary of the four empirical studies on which the present thesis is based, the overview of the thesis ends with a general discussion.

## **Global climate change knowledge**

Current scientific knowledge indicates that the global climate is affected by human activities. The average global temperature has increased by approximately +0.7 °C during the last 100 years, and it is expected to increase more rapidly in the future. Conclusions about warming of the climate system are based on observed increases in air and ocean temperatures, melting of snow and ice and a rising average sea level, among other factors. These changes are not attributed to natural climate variation. The main reason for the

change in temperature is ascribed to human activities causing emissions of various greenhouse gases, for example carbon dioxide. A temperature change leads, among other things, to altered living conditions on earth for plants, animals and humans. Thus, the predicted temperature change will influence the social, economic and ecological balance on a regional, national, and global level. Even though the direction of the change can not be reversed, there are opportunities to act to mitigate the causes and adapt to the consequences (IPCC, 2007b, 2007c). Hence, valid knowledge is important; it gives people a possibility to react and to develop strategies to minimize the negative consequences of global climate change.

On the other hand, it may be difficult for laypersons to comprehend valid climate knowledge. One reason has to do with the climate concept itself, as climate is easily confounded with weather. Both climate and weather involve elements such as air temperature, precipitation, humidity, air pressure and wind (the Swedish National Encyclopedia, 2006). Climate is characterized by statistical properties of meteorological elements, in contrast to weather which is the daily and local event that a person can experience. Examples of statistical properties are mean, standard deviation and highest or lowest value. The effect of a change in mean climate temperature is large. For example, a -5 ° C degree reduction in global climate temperature is equivalent to the mean temperature of an ice age (M. Hedberg, personal communication, December 22, 2006).

A second reason it is difficult for laypersons to acquire valid knowledge involves the characteristics of GCC knowledge. Scientific knowledge of climate change covers many disciplines, such as oceanography, geology, meteorology, and medicine. Hence, the research output is not coherent and even experts may have difficulties in surveying and integrating the knowledge base.

A third reason why knowledge acquisition is difficult is related to the time lag to consequences, which are uncertain by nature. Researchers conceptualize their knowledge of causes and outcomes by using models and simulations. The outcomes of simulations are scientific statements accompanied by confidence intervals to express the scientific uncertainty. Laypersons may have doubts about the value of such knowledge.

In conclusion, it is important that knowledge about GCC is disseminated to members of society. However, characteristics of the knowledge such as heterogeneity, complexity, abstraction and scientific uncertainty are likely to hinder the dissemination process.

## Dissemination of knowledge

The process of disseminating knowledge involves at least a source and a receiver, and it may also involve one or several mediating transmitters. Despite good intentions, there may be disturbances in the process. The information about risky events may be both amplified and attenuated in the transmission. Amplification is an intensification of the signals or messages, while attenuation reduces the strength of the messages. The distortion can happen both in transmission and in reception. Each transmitter alters the original message by intensifying or attenuating some incoming signals, adding or deleting others, and sending a new cluster of signals to the next transmitter or the final receiver, where the next stage of decoding occurs. Intensification increases probabilities and magnitudes of the original content, while a filtering effect implies that only part of the information is transmitted through the chain (Kasperson et al., 1988; see also Kasperson et al., 2003).

Knowledge of climate change has hitherto primarily been disseminated via journalists. Although there are other sources, in the US television has been identified as the primary source of knowledge for the general public (Wilson, 1995, cited in Wilson, 2000). Figure 1 depicts the anticipated flow of knowledge related to climate change. Even though it is assumed that politicians may be informed by experts, their main source of knowledge is journalists.

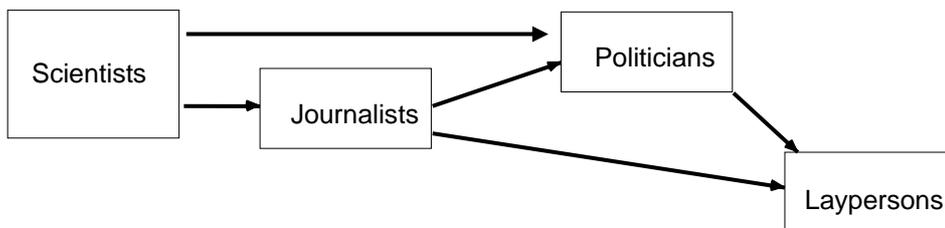


Figure 1. Proposed dissemination of scientific knowledge concerning climate change to groups in society.

Journalists, on the other hand, use newspapers as their dominant source of knowledge, while interviews with scientists and information in scientific journals are their second and third sources (Wilson, 2000).

On the assumption that scientific knowledge is mainly disseminated in accordance with Figure 1, it is expected that the amount or accuracy of knowledge decreases the further the knowledge is transferred. The knowledge

will be filtered, especially as the characteristics of the knowledge may prevent processing of all information.

There is also a difference between the groups in their proximity to the establishment of the knowledge. Scientists have direct access to information in their own discipline, which enables them to have more knowledge. Other groups in society, journalists, politicians and laypersons included, are dependent upon more indirect information.

### **Confidence judgements**

Supporting a filtering effect in communication, Böhm and Pfister (2001) reported that knowledge of climate change among laypersons in the US, as well as in Europe and South America, is vague and contains misunderstandings. Still, people may not always realize this vagueness. For example, in the year 2002 the European public stated that they thought they were well informed about climate change (European Opinion Research Group, 2002).

Ideally, people should be knowledgeable of climate change issues and be confident in this knowledge. They will then be more likely to act in a responsible manner and, as enlightened citizens, be prepared to participate in the political process. A dichotomization of knowledge and level of confidence results in four possible combinations. These four combinations are displayed in Figure 2. To the extent that people are less knowledgeable, their confidence should also be lower. This is a situation where an interest in climate change issues could raise people's level of knowledge. In contrast, if low knowledge is combined with high confidence in one's own knowledge, there is a risk that the lack of realism may lead to actions that are taken on a faulty basis. On the other hand, lack of realism, as when thorough knowledge is combined with low confidence, may result in inaction.

Lack of confidence in one's own knowledge affects further information processes. According to Chaiken, Liberman and Eagly (1989), when people perceive that their actual confidence does not meet a sufficient threshold level of confidence they may be motivated to process additional information in order to raise their confidence. Those who do not have the possibility to process further information will actively search for heuristic cues in their "neighborhood" to increase confidence level (see also Eagly & Chaiken, 1993).

		Confidence in own knowledge	
		High	Low
Knowledge	More	REALISM Adequate action	LACK OF REALISM Inaction
	Less	LACK OF REALISM Misdirected action	REALISM Adequate inaction

Figure 2. Combinations of knowledge and confidence in one's own knowledge.

A number of factors have been claimed to affect both knowledge and confidence in climate change. One of these factors is “source reliance”. Rather than scrutinizing a message, people rely on peripheral cues, for instance, that a message is presented by an expert. They fall back on a simple decision rule: “experts’ statements can be trusted” (Eagly & Chaiken, 1993, p. 327). If people only fall back on “source reliance”, their confidence may be higher than is motivated by their knowledge, overconfidence. In media coverage of climate change, scientists are often cited as being experts in the field.

Other factors are mainly claimed to have negative effects on climate change knowledge and confidence. One of these factors is how knowledge is transmitted. The journalistic norm to balance statements from several sources has been reported to bias coverage of the anthropogenic contribution to climate change. By presenting competing points of view on a scientific issue as if they have equal scientific status, the picture of consensus among scientists is systematically undermined (Boykoff & Boykoff, 2004).

In sum, confidence in one's own knowledge does not necessarily match actual knowledge. The combination of knowledge and confidence in one's own knowledge influences actions.

## Risk judgements

Climate change is often described by the media in terms of risk. By making associations to risk perception and risk judgement, the media signal that climate change is an important issue.

In the “risk-as-feelings” hypothesis (Loewenstein, Weber, Hsee & Welch, 2001), risk perception is a combination of emotional and cognitive judgements and the two components are both directly linked to behaviour. People are traditionally assumed to evaluate risky alternatives at a cognitive level, based on probability and desirability of the consequences, and these cognitive evaluations are expected to influence behaviour. However, cognitive evaluations also cause affective reactions at the moment of judgement, for example as feelings of worry. These feelings exert a reciprocal influence on the cognitive evaluations. In addition, responses to a risky situation result partly from direct emotional influences. The “risk-as-feelings” hypothesis posits that emotions often produce behavioural responses that depart from what individuals view as the best course of action, as emotion can shortcut the cognitive components; see Figure 3. The affective component is dependent on factors such as immediacy of the risk and the current mood of the perceiver. As the determinants of emotional and cognitive evaluations are partly different, emotional reactions to a risk can diverge from cognitive evaluations of the same risk. Consequently, the components can affect behaviour in different ways. Thus, it is important to know the determinants of these risk components.

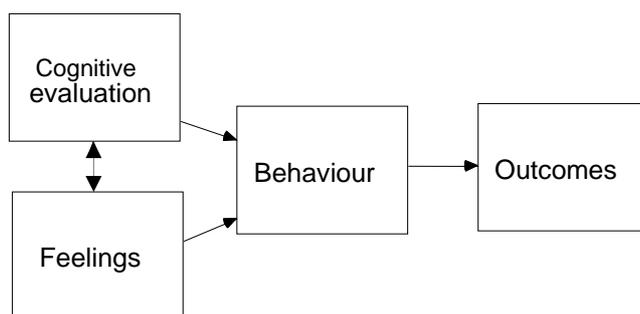


Figure 3. Part of the model proposed in the “risk-as-feelings” hypothesis, by Loewenstein, Weber, Hsee and Welch (2001).

Climate change risk analysis can entail cognitive judgements of probabilities of negative consequences of climate change together with emotional judgements of the consequences. For example, a risk judgement concerning impacts of a sea level rise can include a cognitive evaluation of the

probability that the individual's own coastal house will be flooded and some degree of worry for relatives and neighbours. Worry is one of the most common emotions connected with risk. One can expect that emotional and cognitive evaluations can vary depending on how much knowledge people have in different domains of climate change. In addition, different groups of people may vary in their risk sensitivity.

In sum, knowledge that exists in society can be regarded as important for risk perception. Different groups of people may have different risk perceptions, more or less strongly anchored in a cognitive or an emotional point of view.

### **Scientific uncertainty**

One characteristic of knowledge about climate change is the scientific uncertainty that the research community expresses. An example of scientific uncertainty regarding climate change is found in the Stern (2006) report: "In the longer term, there would be more than a 50 % chance that the temperature rise would exceed 5° C." (page xvi in Summary of Conclusions). Scientific uncertainty is often described as probability levels or confidence intervals and may concern both the state of a resource, the strength of an association and the probability of a consequence occurring.

Uncertainty regarding the state of a common resource has severe impacts on the extent to which people cooperate to manage the situation. There are robust results from social dilemma experiments showing that the resource is overused and runs short when there is uncertainty regarding the state of the resource (Gärling, Gustafsson & Biel, 1999). Social dilemmas are situations in which private interests are in conflict with interests of the collective. In these experiments, lack of knowledge regarding the resource renders the same result independently of whether or not the information contains vagueness, is expressed as an interval, or if the pace of resource replenishment is uncertain. The results have been attributed to over optimism in estimations of the uncertain state. There is a bias to be too optimistic concerning valuable resources, which leads to exploitation (Gustafsson, Biel & Gärling, 1999).

The resource uncertainty in climate change may concern the common atmosphere, but also resources such as plants and water. The information about scientific uncertainty has to be faced as it is, as the uncertainty often can not be eliminated within a reasonable time period. Hence, it is important to determine how people perceive and react to scientific uncertainty regarding the consequences of climate change. IPCC uses likelihood scales that range from exceptionally unlikely to virtually certain in their information about climate change outcomes. The aim of the information is to allow people to make their

own evaluations. As climate change evaluations are related to risk, it is reasonable to expect that a 100 % probability of a negative event is evaluated as worse than if the event is believed to occur with, for example, a 70 % or a 50 % probability.

On the other hand, people may only register that uncertainty prevails and disregard the exact numerical information. Research from choice experiments indicates that thinking is characterized as operating on the main gist of the information, instead of on details, the fuzzy-trace-theory (Reyna & Brainerd, 1991). Hence, the uncertainty information may be radically simplified. For example, an 80 % or a 90 % likelihood of flooding may not be a nuance that people are sensitive to. In that case, people will not respond to all changes in scientific uncertainty and be insensitive to information about increased scientific certainty.

Another reason as to why there may be imbalances between the levels of scientific uncertainty and the evaluation of the uncertainty is that risky events are evaluated both cognitively and emotionally. Facing otherwise comparable alternatives, people are risk averse if they prefer an equivalent less risky alternative only because it is less risky. There may be an additional emotional response related to the extent that the person is risk averse.

Furthermore, the severity of the event may also influence risk perception. For example, domains with dramatic events are perceived as very risky. Nuclear reactor crises are among such events (Sjöberg, 1998). Many of the consequences of climate change, such as severe and sudden flooding, may also be among such outcomes.

Yet another finding from previous research on the effects of limited certainty is that people have a tendency to discount uncertain options. This uncertainty effect is revealed in studies showing that people value a lottery ticket less than the lottery's worst outcome. The "uncertainty effect" has been exemplified in an experiment comparing a sure thing condition with a lottery condition (Gneezy, List & Wu, 2006). For example, participants were on average willing to pay \$38 for a \$50 gift certificate (a 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 (an 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.

Gneezy et al. (2006) suggest that there are necessary prerequisites for the uncertainty effect to occur in their experiments. One of these is to oppose people's internal striving for consistency. The other condition is that values are translated. The translation is suggested to reduce consistence transparency and increase the cognitive workload. Gneezy et al. used a between-subjects

procedure in which participants translated the values from gift certificates to lottery tickets to meet these ends.

There are reasons to believe that the uncertainty effect also pertains to other domains, such as information about scientific uncertainty. For example, a 50 % probability for a negative climate consequence is initially 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 occur with a 50 % probability may be perceived as worse than if they will happen with a 100 % probability. If an uncertainty effect is evoked by the existence of (un)certain information, the intended message may consequently elicit worry and its purpose may be misdirected. Thus, an event that is expected to occur with uncertainty may be evaluated as worse than if the negative event will occur for certain.

### **Distance in time to events**

One of the characteristics of climate change consequences is that many of them are predicted to occur in a distant time. One example involves the predictions of a sea level rise for the next century (IPCC, 2007 b). Since people normally act or react to stimuli that are immediate, more remote issues may draw less attention. Hence, future climate consequences may be discounted when people decide about their present activities. That events are differently valued depending on when they occur was formalized as a theory in the Discount Utility Model (Samuelson, 1937). It has been shown that the discount rate varies in a number of ways. First, discount rates are higher in relation to the near future than to time periods further ahead (Kirby, 1997). Second, there are higher discount rates for smaller events than for larger events, the magnitude effect. Third, the rates vary between domains that have been studied. Financial and health events have been explored most.

Temporal discounting and its causes are defined by Frederick, Loewenstein and O'Donoghue (2002, p. 352) as: "Any reason for caring less about a future consequence including factors that diminish the expected utility generated by a future consequence such as uncertainty or changing tastes".

Research regarding inter-temporal choices, with trade-offs between events occurring at different times, reveals that future events are discounted in some cases but not always. Future monetary events are discounted due to interest and inflation, but also because it is uncertain whether one needs the amount at all in the future. Financial events have annual discount rates that vary within a wide range, from negative to more than 100 % (Frederick, et al., 2002), even

though rate levels around 5 % are common. In comparison, health events have been shown to have higher discount rates, although differences between these domains are claimed not to be a general phenomenon (Chapman, 1996).

Environmentally related risks, on the other hand, seem to have small temporal discounts in comparison with financial risks. In fact, between 30 to 50 % of the respondents in different surveys did not discount environmental risks at all (Hendrickx & Nicolaij, 2004). Thus, people may discount future events in some, but not in all, domains and when temporal discounting does exist the reasons may vary. One proposed reason is uncertainty as to whether one will be affected by the event as one may not be alive at the time. A second reason is that future events may seem less vivid and therefore less salient. A third reason is that future events may seem to be more easily controlled (Nicolaij & Hendrickx, 2003).

It has been questioned whether there is any direct effect of time on discounting (Frederick, et al., 2002). In contrast, the possibilities for indirect effects are many. Evaluation of climate change consequences may vary with time in several ways. For example, a flood that is predicted to occur at a later time, paired with an expectation of an increase in the population size, may be expected to have greater severity than if it were to occur now. On the other hand, expectations of future damages from flooding may be discounted due to expectations of mitigative actions, which hinder the occurrence of the event, or adaptive actions that prevent the worst possible outcomes.

Moreover, there may be other reasons not to discount future environmental risks. One of these is the claim that all lives, even future lives, have the same value. Accordingly, an environmental risk should be equally judged irrespective of if it occurs tomorrow or in 100 years. Such moral and ethical concerns have been proposed to influence environmental evaluations (Hendrickx & Nicolaij, 2004; Böhm & Pfister, 2005).

In sum, temporal discounting of future negative consequences may prevent laypersons and politicians from acting more powerfully. If this is the case, it is also important to try to identify why temporal discounting has such an effect.

## **Knowledge and behaviour**

This thesis investigates different aspects of climate change knowledge. Yet, it is people's behaviour that needs to be influenced to reduce climate change. There are grounds to conclude that knowledge may effect behavioural change. The relation between knowledge and intentional behaviour is described in the theory of planned behaviour (Ajzen, 1991). According to the theory, knowledge, in the form of beliefs that a person holds, is a precondition for

developing attitudes. Knowledge is the foundation of a process in which attitudes, norms and perceptions of possibilities to act are carefully monitored to clarify and decide between behavioural alternatives.

In contrast, it has been argued that increased knowledge will hardly influence behaviour. For example, Stedman (2004) argued that “educational” approaches regarding climate change may have no dramatic impacts on people’s beliefs and ideological positions. Kaiser and Fuhrer (2003), similarly suggested that declarative knowledge alone regarding the environment has limited impact on environmental behaviour. Environmental knowledge can be divided into several forms. Declarative knowledge contains answers to questions about how environmental systems work. Procedural knowledge addresses the issue of how to achieve conservational goals, while effective knowledge concerns the potential to improve certain behaviours. Knowledge has a limited impact on behaviour when the different forms are inconsistent, when knowledge alone is not sufficient to activate behaviour and when there are situational constraints to execute the behaviour (Kaiser & Fuhrer, 2003).

Furthermore, how decisions are made may influence the extent to which knowledge is used. Not all behaviours are planned as thoroughly as is described in the theory of planned behaviour (Ajzen, 1991). Decision methods that are less effortful are proposed in the theory of adaptive decision making (Payne, Bettman & Johnson, 1993). Such methods may reduce or alter the influence of knowledge. However, when reviewing examples from various theories of judgement and decision making, knowledge is a basic component irrespective of decision method.

For example, according to the expected utility theory, choices are made after an effortful process to combine probability and expected utility for all known attributes and alternatives (von Neumann & Morgenstern, 1947). An adjusted decision method (subjective expected utility theory) is used in the theory of planned behaviour (Ajzen, 1991) as utilities are based on subjective probabilities.

Another tack in decision research proposes that people do not scrutinize all facts. Instead, intuitive judgements are made. People rely on a limited number of heuristic principles, which reduce the complex judgemental task (Gilovich & Griffin, 2002). Three examples of such heuristic principles are to use similarity with a model situation (representativeness), to focus on available information (availability) or to adjust from an alternative that is suggested (anchoring) (Tversky & Kahneman, 1974). The heuristic principles have been used as arguments for why it is not efficient to disseminate knowledge to promote change. The idea behind this claim is that knowledge is not used to a great extent. However, even when these decision principles are applied, knowledge is needed to process relevant information.

The “fast and frugal” heuristic research program has also focused on less effortful decision methods (Gigerenzer, Todd, & ABC Research Group, 1999).

The program aims to describe how people make decisions under constraints of limited time as well as of limited knowledge. The heuristics are used to search information, to cease information search, and, to come to decisions. One example is the recognition heuristic, which is to choose the alternative one recognizes from the past. Another heuristic is to focus on just one argument and not involve oneself in more complex considerations. One may conclude that knowledge is needed and used in these fast and frugal cognitive judgements too, even if all new knowledge is not absorbed fully.

An additional decision method is the affect heuristic. Research suggests that representations of objects and events are tagged with affect in people's minds. People think in images, built from perceptual and symbolic representations. Through experience, these images are tagged with positive and negative feelings. When an individual is repeatedly exposed to a stimulus, the mere exposure is capable of creating a positive attitude toward the stimulus (Slovic, Finucane, Peters, & MacGregor, 2002). Thus, repeated exposure to knowledge can create an affective tag which can be used in judgement, independent of cognition.

In sum, knowledge is important and influences judgements, behavioural intentions and eventually behaviour. Even if exposure to new scientific knowledge regarding GCC may not immediately lead to changes in public behaviour, transmission of accurate knowledge is valuable to society.

### **Summary of empirical studies**

The present dissertation had four aims. The primary aim was to study the existence of scientific knowledge as a basis for understanding and judgements of global climate change. A second aim was to investigate how knowledge about climate change is related to risk perception of climate change consequences. A third aim was to investigate the influence of scientific uncertainty on risk perception. A fourth aim concerns distance in time to the future consequences and how this affects people's intention to change their behavior in a more pro-environmental manner.

## Study I

Sundblad, E.-L., Biel, A., & Gärling, T. Knowledge and confidence in knowledge about climate change among experts, journalists, politicians and laypersons. *Environment and Behavior*. Prepublished March, 20, 2008. DOI: 10.1177/0013916508314998.

The aim of this study was to map knowledge and confidence in one's own knowledge for four groups in society; experts, journalists, politicians, and laypersons. We aimed at studying knowledge that is relevant and important to society, and focused on knowledge with high scientific certainty. Three knowledge domains were specified: state, causes, and consequences of climate change, in which weather, ice and sea, and health consequences were separated. The research question concerned the extent to which knowledge and confidence in society mirror current scientific knowledge, considering that information uptake among groups may have been distorted. There are a number of reasons for distortion, for example information transfer as well as characteristics of the content such as scientific uncertainty. The information transfer can attenuate or strengthen the content of the message.

A questionnaire was mailed in October 2005 to all identified climate change experts in Sweden; all identified environmental journalists, all chairpersons of the environmental committees in each municipality in Sweden, and to randomly selected laypersons in the country. A total of 65 experts, 145 politicians, 72 journalists and 621 laypersons responded. The questionnaire assessed knowledge of climate change and associated confidence levels. A second part of the questionnaire included items used in Study II (below).

The results revealed that experts had the highest level of knowledge, followed in order by journalists, politicians and laypersons. In all groups, knowledge of causes of climate change was greater than that of the state and of future consequences. Among the latter, respondents had less knowledge about health consequences than of weather and sea/glacier consequences. Confidence and knowledge showed similar patterns in that the levels of confidence were adjusted to knowledge levels. Hence, there was no indication of over- or under-confidence as a result of the dissemination process. In contrast, on an individual level the realism varied between the groups. The group of journalists was most realistic in their confidence in their own knowledge, closely followed by the experts. Laypersons and politicians were least realistic in their confidence in their own knowledge.

## **Study II**

Sundblad, E.-L., Biel, A., & Gärling, T. (2007). Cognitive and affective risk judgements related to climate change. *Journal of Environmental Psychology*, 27, 97-106.

The aim of this study was to assess determinants of cognitive and affective risk judgements of climate change consequences. The relation between risk judgements and knowledge of various domains, either alone or in connection with demographic factors such as gender, having children or not, education, age and type of residence were assessed.

The questionnaire that was used in Study I included additional questions regarding cognitive and affective risk judgements. Hence, the same group of 621 laypersons as in Study 1 participated. The questionnaire assessed knowledge about climate change, as well as cognitive and emotional risk perception. The cognitive risk component was assessed by the judged likelihood of a serious negative climate consequence due to climate change in three countries, in conjunction with three time frames, while the emotional risk component was estimated by degree of worry for the same negative climate consequences. The final part covered the demographic factors gender, having children or not, level and type of education, age and type of residence.

The results revealed that more knowledge about causes of climate change and of health consequences were linked to higher cognitive and affective risk judgements of serious negative consequences. Gender also had a significant impact on affective judgements. Specifically, women were more affected than men by feelings of worry for severe negative consequences of climate change.

## **Study III**

Sundblad, E.-L. (2008). Evaluation of uncertain climate change information. (*Manuscript*).

The aim of this study was to test if evaluations that laypersons make of climate consequences are influenced by information of scientific uncertainty. Scientific uncertainty is a common characteristic of information concerning climate change consequences. The hypothesis was that uncertain events will be evaluated as worse than if they happen with certainty, an uncertainty effect (Gneezy, List & Wu, 2006).

There were 64 participants in the first experiment that varied scientific certainty from a 50 % to a 100 % probability that specific climate change consequences would occur within 100 years. Unexpectedly, the events were

perceived as less risky in the 50 %-probability group. Previous research (Gneezy et al., 2006) has indicated that the uncertainty effect occurs only if participants are involved in high mental workload task. High mental workload reduces possibilities to strive for consistency. To increase mental workload, we repeated the experiment with a more complicated introduction. As a result, the group (32 participants) informed of a 50 % certainty rated each consequence as more severe, and was also more worried, than the group informed of a 100 % certainty (albeit not a statistically significant difference).

The results of the study indicate that there may be an uncertainty effect associated with scientific information about uncertain climate consequences.

## **Study IV**

Sundblad, E.-L., Biel, A., & Gärling, T. (submitted). Timing of climate change consequences: Its effect on the intention to mitigate CO<sub>2</sub> emissions.

The aim of this study was to test the importance for laypersons of the future timing of climate change consequences. Here, we investigated whether the expected timing of future climate change consequences affects intentions to mitigate carbon dioxide emissions. In addition, reasons why timing was or was not important for willingness to act were examined. Two experiments were performed. In Experiment 1, 90 participants were first informed of climate change and of consequences that would occur either within 5, 25, or 100 years (30 participants in each group). They were then asked to calculate their own current emissions of carbon dioxide with the help of a computer program. After receiving information about their own present emissions, they were asked to report their intention to change the amount of emissions within the next year. In addition, they reported motives for their willingness to reduce or not reduce their emissions. Results revealed that increased time delay did not have an impact on the intention to reduce carbon dioxide emissions.

To a large extent, participants reported ethical motives for emission reductions. To test whether it was the environmental framing of the consequences that influenced people not to discount future consequences, a follow-up experiment was performed in which the consequences were displayed in one of two conditions: environmental or financial terms. The aim was to test whether financial terms could activate discounting of future consequences, as money normally is discounted due to time. Experiment 2 (60 participants) employed a similar procedure as its forerunner, although with only two conditions of future timing, 5 and 25 years. The strength of ethical motives was assessed together with the importance of the motives financial outcomes, uncertainty regarding timing and general environmental concern.

The results revealed that timing did not influence behavioural intentions and the financial framing of climate change had no influence. Unexpectedly, regression analyses showed that the reported motive of ethical concern was unrelated to the decision to mitigate carbon dioxide emissions. The motives of financial outcome, uncertainty of timing or environmental concern were not associated with the decision to mitigate emissions.

## **Conclusions and discussion**

The overall aim of this thesis was to investigate how scientific knowledge of climate change is received by people and how it affects their intentions to take action. Dissemination and evaluation of knowledge is studied as well as the use of knowledge in decisions to reduce carbon dioxide emissions. The purpose was to enhance understanding of the ability of people to react to climate change and to mitigate greenhouse gas emissions.

### **Main findings**

#### *Knowledge and confidence in one's own knowledge*

Experts had the greatest amount of knowledge of climate change, followed by journalists, politicians and laypersons. This result supports the model of dissemination described in Figure 1. However, there were differences in knowledge levels between knowledge domains. Knowledge was highest for causes of climate change, followed by the present climate state and consequences of climate change. The results also revealed that knowledge about health consequences from climate change was especially low, in particular among laypersons. The pattern of knowledge supports a proposed filter effect of information dissemination. This filter effect seems to be equally strong in all knowledge domains.

Another possible reason for the differences in knowledge between groups is that their role in society makes them more or less motivated to learn and process knowledge. Motivation increases the likelihood that people will invest more effort in processing a message (Petty & Wegener, 1998). Hence, even if scientific knowledge is equally disseminated and available for all, different levels of motivation may affect learning and the ease with which people remember the information. However, even though it is possible that the motivation to learn details about climate change varies between groups, the hypothesis of descending motivation from experts, to journalists, politicians

and laypersons awaits future tests. Furthermore, the possible existence of a motivational effect does not exclude a filter effect.

On a group level, confidence in one's own knowledge complied with factual knowledge of each domain. The main source of confidence in one's own knowledge seems to be existing private knowledge. In contrast, on an individual level there were differences between groups revealing that only journalists and experts were realistic in their confidence of their own knowledge. Laypersons and politicians had equally low levels of realism of their knowledge.

A person's role in society may also have affected confidence levels. For example, environmental journalists use current knowledge to disseminate knowledge; they process and repeat the material. This way of working provides confirming and persuasive effects which support confidence in one's own knowledge (Eagley & Chaiken, 1993). In Study I, scientists had high levels of knowledge while their confidence in their knowledge was somewhat lower. The confidence level may be explained by the fact that the work of scientists involves questioning old and generating new knowledge. They are motivated to unveil uncertainties and can be expected to have high standards before they are confident in their knowledge.

The revealed confidence levels may also have other explanations, which may have offset each other. For example, confidence in one's own knowledge may have been increased by reliance on experts. Simultaneously, confidence may have been reduced by media methods where statements are balanced with arguments from other sources. Consensus among scientists is often undermined by a biased coverage (Boykoff & Boykoff, 2004). Another reason as to why overconfidence and underconfidence effects may have been disguised in the present studies is that data were analyzed at an accumulated and aggregated level and not related to a specific message. Such effects may be more obvious at an individual level and in relation to specific messages.

#### *Risk perception related to scientific knowledge*

Increased knowledge was related to an increased perception of risk of climate consequences. The risk perception is influenced both by the amount of knowledge, as well as the specific domain or type of consequence that the knowledge covers. Earlier research on global climate change has reported that more knowledgeable persons perceive higher risk levels than do less knowledgeable persons (Lazo et al., 2000). The present study showed that this enhanced risk perception relates in particular to knowledge of health consequences, but also to knowledge of causes behind climate change. Knowledge of the present state of climate change was not associated with people's risk perception.

Lazo et al. (2000) reported that men perceived somewhat higher risks related to climate change than women did. This stands in contrast to earlier

findings, namely that women perceive risks as being more serious than men do (Rowe & Wright, 2001; Slovic, 1999). It is also contrary to Bord and O'Connor (1997) who showed that women perceived specific threats due to global warming as more likely and more serious, and to Stedman (2004) who reported that women show slightly higher levels of perceived risk of climate change. The present study supports this latter finding. Furthermore, the result shows that it is affective reactions rather than cognitive evaluations that account for this heightened risk perception among women.

The existence of a gender effect on affective, but not cognitive risk perception concerning abstract, serious negative consequences may have several explanations. One reason is the ability to form vivid pictures, which some have suggested could account for gender differences and stronger emotional reactions among women (cf. Loewenstein et al., 2001). Another reason is a stronger perception of vulnerability among women (Bord & O'Connor, 1997). Thus, a combination of the ability to form vivid pictures and greater feelings of vulnerability may explain why women are more worried than men about climate change.

In contrast to gender, none of the other four demographic factors were linked to risk perception. First, associations with having children of your own have been inconclusive in previous research investigating other risk sources than climate change (Johnson, 2004). However, parents sometimes express worry about the future of their children in discussions about climate change. Hence, the present study tested whether parents, compared to childless adults, could be more worried about future climate change due to risks to their children. However, in line with Stedman (2004), no differences in risk perception were found. Second, previous research has shown a relation between educational level and risk perception of sources other than climate change (see Rowe & Wright, 2001). On the other hand, studies on global climate change showed no relationship between risk perception and educational level (Lazo et al., 2000; Stedman, 2004). These mixed results were believed to depend on the fact that a distinction was not made between the cognitive and the affective components of risk perception. In particular, it was proposed that the cognitive component could mediate the effect of education. This assumption was not supported in the present research. Third, an earlier study reported that age is positively correlated with ecosystem risk perception (Lazo et al., 2000). In line with a suggestion by Loewenstein et al. (2001), it was expected that this impact would be mediated by the affective component. However, in agreement with Stedman's (2004) survey, age had no relation with risk perception in Study II. Fourth, reports on climate change consequences have indicated that urban areas will be more severely affected than rural areas (IPCC, 2001b). Hence, it was tested whether risk perception differed between those living in cities compared to those living in rural areas. No association with urbanization level was found. Therefore, only women's

general tendency to report stronger risk perceptions was supported. In particular, this was the case for the emotional component of risk perception.

The extent to which risk perception of climate consequences is influenced by information about scientific uncertainty of the consequences was investigated in Study III. Information about more scientific uncertainty influenced participants' perception of worry and severity of damage from climate consequences, although in different directions in the two experiments. The first experiment required little mental elaboration. The participants made lower risk evaluations when the climate change consequences were claimed to be scientifically uncertain, than when they were certain. In contrast, in the second experiment in which participants were induced to increase their mental workload, risk perception was intensified when the information about an event was uncertain, compared with when it was certain. This tendency is similar to the uncertainty effect (Gneezy et al., 2002). The differences between groups were not statistically significant. The result of the study indicates that efforts to evaluate, elaborate and think through the situation affect risk perception.

#### *Usage of timing information*

How variation in timing of environmental consequences influences people's intention to reduce their own carbon dioxide emissions was investigated in Study IV. The hypothesis was that evaluations of consequences that occur in a distant future are discounted. However, two experiments revealed no significant difference in behavioural intention between conditions that had a longer or shorter time delay. This is in line with the few other studies in the environmental domain (Hendrickx & Nicolaij, 2004; Böhm & Pfister, 2005). In conclusion, timing of consequences may be evaluated as less important, or even unnecessary information, in decisions that affect one's own carbon dioxide emissions.

When participants were asked to report other factors that may have influenced the intention to reduce one's own emissions, further reasons were reported. Ethical motives were the most common reason for willingness to change behaviour. However, statistical analyses revealed that ethical motives were not important for the intention to reduce emissions (on the contrary, there was even a small effect in the opposite direction). Participants seemed to report a reason that was not necessarily correct. In line with Nisbett and Wilson (1977), we suggest that participants' own explanations may have been construed (although not a conscious lie). We propose instead that their reason to reduce emissions of carbon dioxide may have been influenced by the characteristics of the test situation; social pressure activating a norm that one ought to reduce one's carbon dioxide emissions. Furthermore, there were no constraints in the situation that hindered participants in reporting ambitious goals. Hence, these two situational factors may have determined the intention to reduce one's own emissions. This proposal is supported by the fact that

participants who reported reasons as to why they were not willing to act in general referred to situational constraints. For example, they reported that it was necessary to be a frequent flyer to keep in contact with family members who live abroad, and that their limited economy reduced their possibilities to buy ecological food. Hence, we can take the results as yet more evidence that the situation may influence both the decision to reduce as well as not to reduce emissions.

### *Limitations*

In Study I and Study II, laypersons were planned to be randomly selected from the general public. Unfortunately, the survey was affected by an error in the sampling procedure, which was not discovered until the end of the project. Consequently, there are no married women represented in the sample. Still, women living in relationships that are not registered as marriage are included. Thus, the result can not be generalised to the general public in Sweden.

### **Implications**

As scientific knowledge about climate change seems to be disseminated in an unbiased manner in society, a continued transfer of scientific knowledge could promote increasing levels of knowledge in society at large. As a result, evaluations regarding climate change may become more accurate and may also be made with a higher level of certainty.

By specifically increasing knowledge of health consequences and causes of climate change, there is a possibility of raising risk perception of climate change consequences in society. In fact, increasing knowledge will lead to both higher cognitive and affective risk perception. Although risk awareness may be an unpleasant experience, it may also contribute to future welfare by raising attention and motivating activities to mitigate GCC consequences.

People may invest more or less effort in their consideration of information. Two important factors that determine the degree of effort have been identified: motivation and ability (Chaiken, 1980; Petty & Cacioppo, 1986). The more motivated and able people are, the more likely they are to systematically process information. Motivation is primarily determined by relevance or personal importance. Ability is partly determined by situational constraints, such as external distractions or time pressure, but also individual differences in perceived ability to understand and process the information.

This implies that lack of knowledge may serve as a driver among scientists and journalists to acquire more and new knowledge. They are both motivated and have the ability. Politicians on the other hand need to be motivated to acquire new knowledge. Politicians can be under suspicion of being motivated when climate issues are high on the political agenda, but less motivated when

climate issues are not as urgent. In line with Figure 1, information from journalists is an important motivation factor. *That* media present information about climate change signals that the issue is important among voters. Among laypersons, a lack of knowledge may prevent an interest in climate change. Lack of knowledge may also be perceived by laypersons as a lack of ability to process information. Hence, *how* media present information about climate change may affect whether laypersons attend to climate change information or not.

Global climate change represents a new phenomenon that societies are not yet organised to handle. Scientists have alerted us to the problem. However, the roles and responsibilities in society to deal with the situation have to develop. Thus, even if climate change is relevant for all people on a general level, the personal relevance of the problems and accordingly the motivation to process information may be limited. Who should do what to initiate, decide, support, and execute the necessary transformations of society? A dialogue in society regarding how the problems should be handled may help people to perceive that they have a role to play. This may also reduce uncertainty regarding personal relevance. In the long run, clearer responsibilities may increase personal relevance as well as motivation to acquire and process relevant information.

There are many challenges society must meet to mitigate and adapt to climate change. Reduction of fossil fuel usage, development of technology that is more energy efficient and a switch to more public transport are only some of them. Efforts and sacrifices are required to transform society. To be willing to make such changes, the required level of knowledge and confidence in one's knowledge probably must be high. The low level of knowledge among politicians and laypeople today is thus a threat to the transformation process. Furthermore, lack of realism about whether they possess knowledge or not is a threat towards acquiring more knowledge. On the other hand, if acquired knowledge is seen as important, there is hope that people will be inspired to search and acquire more knowledge. A positive sign in this direction is the great attention given to the lectures and the film of Al Gore "An inconvenient truth" (2006/2007) which informed a broad public about GCC. Note that the current research on knowledge was prior to the launching of the film as well as the award of the Nobel Prize (2007) to Al Gore and IPCC. The attention from the public given to these events indicates that people are prepared to attend to the information, and increase their confidence in their knowledge, when the information is delivered in an inspiring way by a trustworthy authority, since trustworthiness can facilitate the acceptance of a message (Petty & Wegener, 1998).

To frame climate information with the purpose to activate emotional instead of cognitive risk perception may influence the extent to which people are prepared to take action. In line with the "risk-as-feelings" hypothesis,

actions that one already intended to perform may be altered because of the fact that affective judgements shortcut cognitive evaluation (Loewenstein et al., 2001). Hence, it is possible that media reports of water flooding may raise affective risk perceptions leading to attempts to learn more about climate change and questioning of present activities with negative environmental consequences.

A final implication of the present research is that information about scientific uncertainty regarding climate consequences may have unexpected effects on risk perception. People are influenced by information of scientific uncertainty. However, their reactions are not necessarily consistent. Hence, as scientific uncertainty sometimes increases risk perception, the advice to information providers is to be cautious when including information of scientific uncertainty.

### **Future directions for research**

The present thesis reveals several paths for future research. One of them is related to the link between knowledge about GCC and risk perception. Even if one may reasonably assume that knowledge causes risk perception, the causality may also be in the other direction. Hence, it is possible that risk perception motivates people to process information in more depth. According to the elaboration likelihood model (Petty & Cacioppo, 1986), information may affect processing via two different routes. The “peripheral route” requires a minimum of effort. When both the motivation to have valid information and the ability to process information are high, the “central route” which requires more effort, is used. The central route represents argument-based thinking. Attitudes formed or changed via the central route are suggested to be relatively persistent over time, predictive of behaviour and resistant to change until challenged by good counter-arguments (Eagly & Chaiken, 1993; Petty & Wegener, 1998). Risk perception may be one source of motivation for effortful information processing. Hence, such information processes may increase knowledge and even predict behaviour. Experiments are needed to clarify the direction of causality between risk perception and knowledge elaboration.

Another issue concerns the relation between gender and risk perception. It is important for policy makers and information providers to know which factors that can motivate different information receivers to perform different types of activities as well as to support others. Previous research has revealed that cognitive risk perception and knowledge of causes of climate change increase people’s willingness to act on the causes of climate change. O’Connor, Bord and Fisher (1999) found a gender difference related to both voluntary actions and to voting actions. Women indicated stronger intentions to take a number of voluntary actions while intentions to vote for various

governmental programs or activities were supported more by better educated, older men. The gender difference was suggested to reflect activities with which the group is comfortable. Still, their study did not assess both cognitive and affective components of risk perceptions as in the present study. Thus, future research may reveal whether it is responses to affective judgements that explain gender differences towards certain activities.

A third issue concerns scientific uncertainty. The hypothesis that uncertainty in some situations may cause evaluations that are more negative than if the event were to occur for certain, was suggested by Gneezy et al. (2002), and labelled the uncertainty effect. Their result was based on uncertainty in lotteries. We found a tendency in the same direction in one of the experiments in Study III. Ortmann, Prokosheva, Rydval and Hertwig (2007) replicated the most convincing experiment of Gneezy et al. and also included a parallel experiment in which they changed the lottery situation and reworded it to information of a 50 % probability. They did not reveal an uncertainty effect in any of their experiments. Still, Ortmann et al. (2007) suggested that mental workload may have contributed to the differences in results between their two studies. This suggestion is also in line with the result here, and with the result of Gneezy et al. Hence, future research of the effects on mental workload for evaluation of risk may clarify the mechanisms involved in the uncertainty effect.

An area of research adjacent to that on the direct effects of scientific uncertainty concerns the inferences that people may make when they are informed about scientific uncertainty. Previous research has proposed that the method for informing people about the certainty percentage, say 90 %, for a risky event without revealing the other potential options and their probabilities opens for negative influences on the evaluation. This is called a penalty effect (Ebenbach & Moore, 2000). Penalty is thought to be caused by the mere lack of information. On the other hand, there is also a possibility that people infer other negative outcomes instead of the information that is lacking. If, and when, a penalty effect influences how information about climate change is processed deserves attention.

The evaluation of climate consequences was not related to timing of the consequences in the present research. Although this is in line with other environmental studies, it diverges from results on temporal discounting in the finance domain. The unimportance of timing information has been associated with ethical considerations, both by participants in the current study and in previous research. Despite these indications, neither we nor other researchers confirm that ethical motives reduce the “rationality” of temporal motives (Böhm & Pfister, 2005). Instead, we suggest that the result is dependent on the methods of the study. It may be difficult for people to envision events they have never experienced before, and time delays of 100 years. This is longer than a normal lifetime. Nevertheless, the establishment of when and why

environmental consequences are discounted needs further investigation. In addition to ethical motives, other reasons for the difference between in discounting between environmental and financial domains should be analyzed. One track that may be fruitful is to investigate social dilemma characteristics for the decision situation. For example, norms of various types can be involved in the situation.

Furthermore, there are several other characteristics of climate consequences that also have a distance dimension, which may result in discounting of the event. In addition to the timing of climate consequences, there is a geographical distance to where the consequences occur, and a social distance to the people that are affected. Even though Gattig and Hendrick (2007) suggest that discounting mechanisms are stable across different preference dimensions (uncertainty, temporal, spatial and social distance), this is not clarified regarding climate change events.

Finally, the range of activities related to GCC does not only concern how to prevent the causes of GCC, that is, mitigative activities. There are also adaptive activities to reduce negative consequences of GCC. Adaptive and mitigative activities may be influenced by different risk judgements. Even persons who are not worried and judge negative GCC consequences to be highly unlikely may be willing to act to prevent negative consequences in the face of a potential disaster, for example to build banks to limit flooding and to help people in emergency situations. Such concrete adaptive activities, related to on-going negative consequences, will call for immediate resources and leadership in society. In contrast, decisions concerning mitigating activities to efficiently prevent the causes of GCC are made with a higher degree of uncertainty. Such decisions will be difficult to make as they are future-oriented. People must change their course of action, despite the fact that they will not themselves experience any immediate environmental benefits. Hence, mitigating activities will probably need more support in the form of more knowledge and stronger attitudes towards risk. Thus, it is especially important to identify predictors in support of mitigation.

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