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# Perceptions of time in relation to climate change

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Time is at the heart of understanding climate change, from the perspective of both natural and social scientists. This article selectively reviews research on time perception and temporal aspects of decision making in sociology and psychology. First we briefly describe the temporal dimensions that characterize the issue of climate change. Second, we review relevant theoretical approaches and empirical findings. Then we propose an integration of these insights for the problem of climate change and discuss mismatches between the human mind, surrounding social dynamics, and climate change. Finally, we discuss the implications of this article for understanding and responding to climate change, and make suggestions on how we can use the strengths of the human mind and social dynamics to communicate climate change in its temporal context. © 2014 John Wiley & Sons, Ltd.

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## PERCEPTIONS OF TIME IN RELATION TO CLIMATE CHANGE

Climate change refers to long-term changes in weather patterns, observed over at least several decades.<sup>1</sup> Among these are higher surface air temperatures ('global warming'), sea-level rise, variations in precipitation, and more frequent extreme-weather events.<sup>2</sup> Climate change impacts are wide-ranging and include changes in species range<sup>3</sup> and human health.<sup>4</sup> Climate change requires urgent mitigation and adaptation efforts.<sup>2</sup> Despite the scientific consensus many commentators have observed a lack of action<sup>5,6</sup> and have called for public debate and engagement.<sup>7–9</sup>

This article will selectively review sociological and psychological research on time perception and temporal aspects of decision making. In particular we will develop the idea that time is an important aspect

of the broader dimension of distance and may be linked to other facets of distance such as space and social distance.<sup>10</sup> Note that this article is a discussion piece rather than an exhaustive review, presenting key findings but only scratching the surface of a vast area of research. Since the focus is on broad perceptions, we do not discuss economic approaches (such as economic discounting rates), nor do we focus on scenarios which are addressed elsewhere in the issue. Our main aim is to promote a serious conversation on the key role of time perceptions in addressing climate change.

First we briefly describe how climate change is commonly framed in scientific discourse (e.g., typical time horizons used). Second, we observe a number of fundamental constraints that make dealing with the timescales of climate change challenging for people and for societies. Third, we review theories and findings from the sociology of time. Fourth, we review relevant theories and studies from psychology and begin to relate these to behavioral responses. Fifth, we propose an integration of these insights and discuss mismatches between the human mind, surrounding social dynamics and the problem of climate change. Finally, we discuss the implications for understanding and responding to climate change, and briefly review emerging communication and intervention strategies. We make suggestions on how we can play to the

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strengths of the human mind and social dynamics to help overcome these mismatches in time perceptions.

## THE TEMPORAL DIMENSIONS OF CLIMATE CHANGE

There are a number of temporal dimensions that characterize the biophysical phenomena of climate change. Perhaps the most basic temporal dimension of climate change is its *extension into the future*. While impacts are already happening, the most significant and far-reaching impacts of climate change lie in the future. Thus there is a distance between our lives now and these future climate change impacts. Scientists use scenarios to model future climate change effects, with typical target dates of mid- and end-21st century.<sup>2,7</sup> The Stern Review on economic impacts<sup>11</sup> mostly uses a time horizon of 2050. The short and long-term patterns of past climatic conditions are also a key part of the science in setting baselines for future change, but this article will focus mostly on the future dimension and the concept of temporal distance. A further temporal aspect of climate change which complicates temporal distance is the *time lag* between cause and effect.

The climate effects we see now are related to carbon emissions that entered the atmosphere a long time ago. Even if we stopped all additional carbon emissions today, the carbon already in the atmosphere will continue to have impacts for centuries. For example, we would still see warming of about 0.1° per decade if we had kept carbon emissions at 2000 levels.<sup>2</sup> The US National Research Council (Ref 12, p. 3) summarizes these delays as follows: '[e]missions reductions choices made today matter in determining impacts experienced not just over the next few decades, but in the coming centuries and millennia.'<sup>a</sup> Next we take a closer look at some fundamental constraints on the human mind and society that are relevant to the temporal dynamics of climate change.

## FUNDAMENTAL CONSTRAINTS OF THE HUMAN BRAIN AND SOCIAL STRUCTURES

Beyond the temporal dimensions inherent in the physical phenomena of climate change, human response mechanisms have their own temporal dynamics and constraints. From an evolutionary point of view it is not surprising that individuals and society have difficulty understanding and dealing with the climate change challenge. The human brain developed in a time when humans were largely concerned

with their direct environment (e.g., foraging for food) and immediate dangers (e.g., from predators). Thus humans are geared to prioritize short-term consequences of behavior and immediate futures. Evolutionarily, we are also used to close cause-effect relationships rather than those characterized by time lag and lack of contiguity.<sup>13,14</sup> While our brains have evolved over millennia, the carbon challenges we are facing today have only emerged in the last century. No wonder our 'ancient brain' (Ref 15, p. 291) is lagging behind today's rapidly developing complex challenges.<sup>16</sup> In addition, increasingly urban lifestyles mean we are distanced from gradual shifts in seasonal cycles, weather patterns and environmental conditions. Moving to cities reduces access to local accounts and oral histories of past patterns available to more rooted, place-based rural families in farming and forest-dwelling communities,<sup>17</sup> which can provide a baseline to compare changes against.<sup>b</sup>

Moreover, humans live in a social context that co-evolved with the brain and other physical adaptations. Evolutionarily, we are used to living in small groups and having direct contact with those group members. Members of our social group were the social agents to whom we were accountable first and foremost. Accordingly, the ethical frameworks used in thinking about the impacts of our actions have typically been geared to situations of immediate face-to-face relationships and where chains of responsibility can be easily established.<sup>18</sup> This is reflected at a societal level, where legal institutions struggle to deal with liability where causal chains are hard to establish, and where consequences may not easily have been foreseen before acting.<sup>19</sup>

Climate change time dimensions clash with shorter societal time constructs, e.g. 4 year election cycles, and 5–20 year time-horizons used in community planning or cost-benefit analysis.<sup>20</sup> Tonn et al.<sup>21</sup> found in their surveys that people on average thought about the future as about 15 years out, with very limited ability to imagine the future beyond 10–20 years. The standard timelines (e.g., 2050, 2100) used by climate scientists are therefore not meaningful to the general public, in those limited occasions when scientists and the public interact (e.g., as in publicized activities of the Intergovernmental Panel on Climate Change).

Therefore, both psychological and societal factors contribute to the difficulties humans have in responding to events characterized by distance such as climate change. That distance in space and/or time is a key determinant of moral motivation and action has long been recognized by philosophers, at least since the Stoics articulated the concept of *oikeiōsis*, which

was appropriated centuries later by Adam Smith,<sup>22</sup> in arguing that the proximity of an individual is directly relevant to our actions toward him or her.<sup>23</sup>

Societal time lags are also apparent between the emergence of scientific evidence and regulatory responses.<sup>24</sup> Greenhouse gases and their effects have been studied since John Tyndall's work in the 19th century, and US scientists began to warn policy makers about global warming in the 1960s.<sup>25</sup> Despite the existence of early warnings, evidence from other domains confirms that legislative responses can take several decades. For example, the adverse health effects of tobacco were publicized from the 1930s onwards but smoking bans only became widespread in Europe from 2000 onwards. Compared to the regulation of tobacco, carbon emissions relate to almost every segment of modern life, and addressing it 'requires billions of people to reduce their carbon footprint' (Ref 26, p. 533). Sterman and Booth Sweeney<sup>24</sup> observe that a 'wait and see strategy' is popular amongst the general public and policymakers, but argue this only works in simple systems with short time lags, very unlike the climate change system.

In summary, it should be no surprise if individuals and social groups find the issue of climate change difficult to comprehend and act upon. The next sections will review in more depth theories and findings on time perspectives relevant to climate change. First, insights from the sociology of time will be described, followed by key concepts arising from the psychology literature. We will summarize relevant general insights about temporal processes from these literatures and draw on environmental or climate change examples wherever possible.

## THE SOCIOLOGY OF TIME

The emerging field of the sociology of time,<sup>27</sup> together with environmental sociology,<sup>28</sup> have emphasized that social practices and natural processes are bound together in a relationship of co-construction, in which 'consonance or dissonance' between the two is produced through different forms of timing, tempos, and rhythms.<sup>29</sup> Social and natural systems are linked at different levels, which might be thought of as a set of nested relationships between different temporal scales over which change occurs at different rates. These scales range from the deep time of geological transformation to the accelerated rhythms of high-volume automated economic exchanges on the world's trading floors. The relationship between society and nature is not only shaped by the spatial scales of causal processes but also by their temporal balance or imbalance. The fastest rhythms of change may

create ripples that transform the slowest. For example, the intensification of economic activity made possible first by industrialization<sup>30</sup> and then by information technology, may accelerate historical change but, through its impact on the emission of greenhouse gases (GHGs), may also affect the vastly longer-term climatological and geophysical processes implicated in climate change. The social organization of industrial production therefore links everyday human activity with other time scales, all the way up to the evolutionary and geological scales of the deep future, as with climate change and species extinction.<sup>31</sup>

Human action can thus be understood in terms of its *timescape*, its embeddedness in a context of ongoing processes at different temporal and spatial scales.<sup>32</sup> The interactions between natural and social systems are structured around their own characteristic rhythms, and extend themselves into the past and future. This provides a sense of temporal and spatial context<sup>33</sup> which can alert us to timescapes or legacies of action that may greatly exceed everyday or standard economic and political time horizons. For example, practices which typified agriculture until the Industrial Revolution were linked strongly to natural rhythms of climate variation and seasonal growth and decay. Sustaining agriculture required knowledge of these rhythms and careful interpretation of signs of the future. However, the introduction of inputs from beyond this context (such as oil-based fertilizers) introduced other processes (such as soil depletion, phosphate pollution, and 'peak oil') into agricultural timescapes that changed their character, and with it, their potential futures (Ref 32, pp. 131–138).

The sociology of time can also alert us to how the temporal patterns of social practice have changed in tune with other social transformations. It highlights how these shifts are related to changes in *time consciousness*, to alterations in how people and cultures attribute meaning to the past, present, and future. Our subjective sense of time is changed by experience, which has both social and material (including technological) conditions which themselves are subject to change.<sup>27,34</sup> The perception of time can thus be seen as something which is socially produced or constructed, based on how social practices prioritize particular elements of reality as salient to their goals. The passage from agriculture to industrial capitalism, for example, brought with it significant changes in the subjective time of individuals as well as in the objective temporal patterns developed within institutions.<sup>35</sup> The transition from peasant to industrial economies was supported by new ways of measuring and marking time that removed human activity from the constraints of the cycles of day and

night. This allowed new forms of production that characterized industrial societies, but also changed the meaning of the past and especially the future.

A particularly important example of this transition in our relationship to time is intensification.<sup>36</sup> The goal of intensification is to use each instant of time as efficiently as possible. As a new way of conducting social activity, it became possible through a specific shift in the social meaning of the future. During the 17th and 18th centuries, the future became increasingly conceptualized for the first time in its totality<sup>37</sup> as a collection of interconnected possibilities. The new science of probability played an important role in this<sup>38</sup> by assigning both probabilities and expectation values to future possibilities, based on the degree of benefit or harm associated with them. As a result, the future became a new field of expert knowledge. The increasing use of risk and cost-benefit analysis in governance during the 19th and 20th centuries furthered this transformation of the future into a calculable object (Ref 39, p. 247), and thereby an object of public management and planning, but also one of private exploitation.<sup>40</sup> The future was therefore constructed in a specific way: it became 'empty'<sup>41</sup> or 'mechanized.'<sup>37</sup> It effectively became a territory to be controlled (as in efforts to, e.g. use sanitation to reduce health risks from epidemics) but also occupied, colonized and exploited (e.g., by futures trading, in which future prices of commodities such as fossil fuels form the basis of trades in the present and reshape, in the process, future outcomes).<sup>42</sup> The extension and broadening of human expectations of control over the future differentiates the future constructed within modernity from that of previous epochs, in which posterity was seen as belonging solely to supernatural powers.<sup>41</sup>

This new focus within social institutions on planning the future may have unintended consequences, however. Emptying the future also made intensification possible. Efficiency could now be measured by scientific time-and-motion studies undertaken under Taylorism, or by increases in the number of trades per second in automated high-frequency trading (HFT) in financial markets.<sup>43</sup> Intensification does not necessarily produce more reliable outcomes, however. Rather, it may increase the likelihood of unanticipated consequences by speeding up the rhythms of social action<sup>44</sup> and by increasing the possibility of 'interference effects' between different activities.<sup>45</sup> In this way, it reshapes established timescapes of action, as in the example of agriculture given above. It increases the likelihood that actions undertaken on one temporal scale may affect other rhythms of activity and change. For example, futures trading in fossil fuels may create,

over time, patterns of wider activity (e.g., investment in unconventional oil resources) whose consequences then intersect with the timescapes of interlinked natural and social processes.<sup>42</sup> In turn, interactions between the economic colonization of the future and processes that ensure the short-term economic health of societies affect climate change (e.g., by making the exploitation of tar sands economically viable and releasing more GHGs).

Yet in modern societies which prize innovation, the short-term economic and political competitive advantages (such as freedom to manoeuvre and pursue one's own interests) tend to accrue to social actors who are able to adapt, in the shorter term, to intensification by making and justifying decisions quicker than others through socially accepted forms of expertise. Such advantages are enhanced if actors can offload the consequences of their action (e.g., externalities such as climate change impacts) upon others far away in space and/or time. This secures benefits for some actors by producing islands of security and certainty for them while producing uncertainty for others (Ref 46, p. 20).

So, transformations in social temporalities can be the source of both social conflict and material instability due to the effects they exert on the social and natural worlds. The imperative to seek autonomy and flexibility of manoeuvre for short-term advantage by avoiding longer-term commitments leads some actors within societies (such as high-carbon industries) to employ practices which colonize the future as a resource for the present.

Such 'strategies of autonomy' can be contrasted with strategies based on solidarity and collaboration, aimed at developing more resilient communities. Marris<sup>47</sup> argues that some social groups (typically those concerned with the longer-term consequences of their actions, ranging from traditional societies to some business communities) tend to pursue action based on practices geared to, for example, fostering reciprocal commitments and mutual aid, preserving the stability of places and environments, and pooling risk. As a strategy for reducing uncertainty, solidarity deals with a different timescape than that associated with the quest for autonomy. It stems from socially conditioned understandings of time and future, and is thought to be rooted in noninstrumental attachments to place, to other people and to institutions.<sup>48</sup> Yet while these attachments foster social trust and reliable expectations of the future, they also expose those which rely on them to greater vulnerability and uncertainty within social systems that favor intensification and reward, in the short term, autonomy and flexibility. This distinction between future-oriented strategies reveals the potential for

conflicts between agents with the power to shape faster and more extensively the future and those agents whose futures are effectively colonized by the strategies of others.

At the same time, economic inequities may reduce any tendency of social actors to discount the future. For example, evidence from studies of African countries demonstrates that poverty and vulnerability do not, as one might expect, lead to high rates of temporal discounting.<sup>49</sup> On the contrary, people subject to poverty may be more likely to make sacrifices in the present so as to maintain productive capacity for the future (Ref 49, p. 320), suggesting that ‘myopic self-interest is culturally circumscribed’ (Ref 49, p. 323). This suggests that a key influence upon temporal perception and how it affects action may be the implicit or explicit normative frameworks associated with particular social practices, and how these are embedded in groups and institutions.

## PSYCHOLOGICAL PERSPECTIVES ON TIME

If research in the sociology of time demonstrates how the rhythms and tempos of social practices create constraints within which groups and individuals must operate, psychological perspectives can complement these insights by examining social and cognitive processes at the level of the individual. The focus here is on the role of temporal aspects of individuals’ perceptions, judgements, and decisions.<sup>50</sup> Memories of the past are used to simulate the future, and both processes share regions in the brain<sup>51</sup>; thus psychological processes concerning past and future are intertwined. Moreover, past and future are characterized by their distance from the here and now of direct experience.<sup>52</sup> The following sections discuss psychological concepts relevant to the perception of time in the context of climate change.

### Optimism about the Future

Broadly speaking, people have a tendency to focus on good things both in the past and in the future. We recall positive aspects about the past better than negative aspects,<sup>53</sup> and we generally expect good things to happen to us personally.<sup>54</sup> Such generalized expectations for the future are relevant to perceptions of environmental and climate change.

McElwee and Brittain<sup>55</sup> were the first to link outlooks for the future with environmental issues. In their study, people who were more optimistic about a range of possible future events that might happen to either themselves (e.g., contracting an

illness) or to the world (e.g., war) were less concerned about the environment. Building on this, Pahl and Boomsma<sup>56</sup> developed the optimism–pessimism scale for environmental change (OPSEC), which asks participants to rate their agreement with statements such as ‘I imagine clean air and green spaces when I think about the UK in 50 years’ time’ and ‘we will discover additional environmental problems within the next 50 years that we don’t even know about now.’ Participants in three samples (students, general public, and climate skeptics) were neither optimistic nor pessimistic; their opinions were, on average, neutral, which indicates a great degree of uncertainty over the future. However, those who were more optimistic displayed lower environmental concern. Moreover, among climate skeptics in particular, more optimism was associated with less guilt, less perceived responsibility and lower behavioral intentions. Thus, overall, optimism seems to be negatively associated with an active response to environmental change.

Beyond a generalized outlook for the future, people make a distinction between themselves and similar others. They think that they will have a rosier future than will others. This ‘*optimism bias*’ has been shown for self–other comparisons (i.e., I am safer than others), for families and communities (i.e., we’re safer than other families and communities), and also for spatially based judgements (i.e., our local area is safer than are other areas),<sup>57,58</sup> for a range of issues including health risks resulting from environmental pollution.<sup>59,60</sup>

However, optimism bias is not ubiquitous. It disappears when people are told pollution is the result of an accident,<sup>60</sup> which could be because of lack of perceived control under such circumstances. Moreover, Sweeny et al.<sup>61</sup> describe in a seminal paper how optimism may change in response to preparedness demands. When a ‘moment-of-truth’ approaches, people may shelve optimistic beliefs in order to be prepared for dealing with a potentially negative outcome. This could be crucially important for the temporal dynamics of climate change perceptions. However, while Sweeny et al.<sup>61</sup> focus more on mundane events such as exam results and health-related behavior where one readily encounters moments of truth (e.g., results day, a health assessment), the crucial moment of truth might not be encountered easily in climate change. This adds to the challenge when communicating climate change and motivating people to take action.

### Cognitive Biases and Direct Experience

Optimistic beliefs may be related to other cognitive biases.<sup>c</sup> The *availability heuristic* suggests that people

base their judgements on information that is readily available in memory.<sup>62,63</sup> Following from this, if it is easy to recall information and images of a plane crash, for example, the risk of such an event occurring will be overestimated. If evidence for climate change events is difficult to retrieve from memory, climate risks will be underestimated (or biased toward very salient information or images). Moreover, information about climate change faces stiff competition from the media barrage and other daily issues that are simply more salient, compelling and urgent in demanding our attention.<sup>64–66</sup> Even if people have explicit goals for dealing with climate change, for example by reducing their personal carbon footprint, there are other issues that demand attention more readily. In addition, research in cognitive psychology has indicated that individuals experience less emotive mental imagery with respect to generalized long-term goals (such as living more healthily or sustainably) compared to short-term goals (such as eating a doughnut or driving to the shop), because the former are less engaging and may lack specific cues in our daily environment that trigger appropriate action (whereas a doughnut might be displayed in a shop we walk past, with additional multi-sensory cues such as smell).<sup>67</sup> Long-term personal goals related to climate change tend to be less specific and more difficult to maintain as salient in daily life. Related to this, ‘climate change’ is not a behavioral domain as such - it may become a frame within which tangible behaviors can be situated, such as making choices about thermostats, diet, travel, etc.

These types of influences may contribute to the perceived distance of climate change and hinder mitigative or adaptive responses. Strictly defined, future impacts cannot be experienced directly (but see section *Toward Solutions in Time Perceptions of Climate Change*). However, direct personal experience (a point of zero distance) is thought to affect risk perception and concern. Akerlof et al.<sup>68</sup> found the more personal experience of climate change effects Michigan residents reported (e.g., milder summers, less snow) the higher were their perceptions of local climate change risks. Similarly, Spence et al.<sup>69</sup> demonstrated that personal experience of flooding was correlated with concern over climate change and willingness to save energy. Whitmarsh<sup>70</sup> also found evidence for this association in experiencing air pollution but not flooding. However, none of these specific studies provide direct evidence for a causal link between personal experience and increased perceptions of climate change. It could be that people who are aware of climate change interpret their experiences differently or are more sensitive to environmental change.

## Psychological Discounting and Risk Perception

Many studies have shown that people place less value on the same outcome the further in the future it lies; future rewards appear less appealing the more distant they are.<sup>71</sup> In the same vein there is some evidence that people rate environmental and financial consequences less important the more delayed these are.<sup>72,73</sup> Gattig and Hendrickx<sup>74</sup> suggest that negative outcomes are taken less seriously to the extent that these outcomes are characterized by high uncertainty, long delay and distant places, all of which are dimensions associated with psychological distance.<sup>52</sup> For example, Moser et al.<sup>75</sup> found that over very long timescales (up to 1 million years), risk judgements for nuclear and other hazardous waste reduced with temporal distance. In their study, a stronger belief that future societies could deal with waste was associated with lower risk, whereas more emotional involvement was associated with higher risk.

However, other evidence suggests that temporal discounting does not necessarily apply to environmental risks<sup>76</sup> (see also Ref 75) and that future outcomes are viewed as *more* risky.<sup>77</sup> Gattig and Hendrickx<sup>74</sup> review six studies, some of which show the predicted effect (of lower severity with increased distance), whereas others find no effect of distance. Sundblad et al.<sup>77</sup> investigated environmental risk judgements in a Swedish sample for consequences varying in time (5, 50, or 100 years from now) and location (Sweden, Holland, or Bangladesh). Additional analysis of their data showed that environmental problems were perceived to be more probable and worrying with increasing temporal and spatial distance. Uzzell<sup>78</sup> (see also Ref 79) focused on spatial distance and showed that environmental problems were perceived to be more serious at the global than the local level. These findings are not quite in line with Gattig and Hendrickx<sup>74</sup> conceptual analysis, according to which distant problems (spatial or temporal) should be discounted more and thus perceived as less serious than close problems. However, they are consistent with the optimistic bias findings reviewed above, according to which people perceive lower risks for themselves and close others than for distant others. In sum, temporal and spatial distances do not seem to have uniform effects on judgements across studies. While some studies carefully control potentially confounding factors,<sup>72</sup> other studies’ inconsistent findings might be explained by third factors such as the type of risk, or its scope. For example, ‘global’ impacts could be seen to incorporate ‘local’ impacts.

Finally, an approach termed the psychometric paradigm has described how nonexpert views of

risk differ from expert views<sup>80</sup> and offers insights into the role of time in this process. According to Slovic<sup>80</sup> two sets of factors are associated with higher perceptions of risk: perceived dread, severity, and catastrophic potential (labeled 'dread risk') and unfamiliarity, delay, and lack of observability (labeled 'unknown risk'). Delay is the only obvious temporal dimension that has received support here, although lack of observability also relates to the dimension of psychological distance. People can observe events in the here and now, but they cannot directly observe future events. Without the opportunity to observe or experience directly, events have to be construed in people's minds. Construal level theory analyzes these construal processes as a function of distance, and is discussed next.

### Abstractness of Future Outcomes (Construal Level)

Trope and Liberman<sup>10,52,81</sup> coined the term *psychological distance* to 'describe the subjective experience that something is close or far away from the self, here, now' (Ref 81, p. 440). As mentioned above, in addition to temporal distance, these authors argue that space, social distance and even hypotheticality are also facets of the broader dimension of distance. Psychologically distant events are represented in 'why' terms, using abstract, schematic, and decontextualized mental representations that are related to meaning. Psychologically close events are represented in 'how' terms, focusing on feasibility and including rich details of the situation. For example, thinking about a foreign summer holiday in a year's time, the focus would be on the lovely destination, on relaxing and having time for the family. The day before embarking on the holiday the focus would be on packing suitcases, remembering passports and preparing to navigate unknown cities and languages. Whether environmental change is perceived as psychologically distant or close may be important in how strongly people will react to environmental change.

Initial evidence for construal processes in the environmental domain was reported by Pahl.<sup>82</sup> Participants were asked to describe a behavior in terms of 'how' or 'why' and then indicate their intentions for that behavior. For example, when asked to consider *how* one can reduce plastic bags, participants estimated they would engage in this behavior sooner, than when asked *why* one would want to reduce plastic bags. A simple difference in framing behavior in how or why terms had an effect on temporal intentions. This is broadly in line with literature on action control and planning in the health

domain (see Ref 83 for an overview), which has shown that construing a behavior in terms of 'how' is predictive of health behavior.<sup>84</sup> To our knowledge, the effects of 'how' construals have not been tested in the environmental domain, although specifying behavior in terms of 'where' and 'when' has been tested (see Ref 85 for a summary on implementation intentions). These construal processes require further testing in the environmental domain but could be important when trying to engage people with climate change, as communications are frequently based on addressing motives and values rather than feasibility and the 'how' of action planning. In the same series of studies,<sup>82</sup> participants who explained why they thought climate change occurs rated the likelihood of climate change as lower than participants who described how climate change manifests itself. This could be important in a context of public discourse that frequently focuses on reasons for climate change rather than manifestations.

Spence et al.<sup>86</sup> recently studied psychological distance in relation to climate change in a representative British survey. Their data showed mixed results regarding how distant participants felt from climate change. Participants thought climate change would affect geographically distant as well as close areas and people similar to themselves as well as those in developing nations. Most importantly, 41% of people in this study thought that climate change was already affecting Britain, with less than 5% choosing each of the options 'in the next 100 years/beyond the next 100 years/never.' Thus, in this particular study there was limited evidence that people felt psychologically distant from climate change, particularly with regard to temporal distance. However, psychological closeness (in terms of impact on local areas and 'people like me', and for 'we are already feeling the effects') was positively related to increased concern about climate change and preparedness to act.<sup>d</sup> People who felt subjectively close to climate change were more concerned and willing to take action. This supports the importance of psychological distance proposed by construal level theory.

Construal might also be important for addressing the attitude-behavior gap. While people often report positive attitudes for future environmental behavior, this is not necessarily reflected in real actions. Rabinovich et al.<sup>87</sup> proposed that this attitude-behavior gap can be reduced by making a distant-future perspective salient. Participants were asked to describe their country's environmental situation in 10 years (distant future) or in a month's time (close future). Attitudes and intentions were more

strongly correlated in the distant future scenario than in the close future scenario. This is in line with construal level theory's assumption that far distance is associated with meaning and values, and that small detail and feasibility considerations play a bigger role when considering the near distance, possibly interfering with one's valiant longer term goals.

### The Role of Individual Differences in Time Orientation

The studies summarized so far have focused on temporal processes that are common and shared within the human psychological system. However, another area in psychology describes consistent enduring differences between individuals. For instance, people can be distinguished by their preferred *time orientation*. Some people habitually prefer a future time perspective, characterized by subjectively important and meaningful mental representations of the future and a focus on future goals and achievements, whereas others habitually think more about the past or the present.<sup>88</sup> Milfont et al.<sup>88</sup> summarize the literature on individual differences in using time perspectives, and relate this to environmental engagement. Aggregating over 19 studies and more than 6000 participants, these authors show that stronger future time orientation is associated with thinking about environmental problems and taking steps to address these. This research suggests that stable, enduring person differences in time orientation may also play an important role in determining individual and collective responses to climate change.

### INTEGRATING INSIGHTS ABOUT THE HUMAN MIND AND SOCIETY

This section attempts to synthesize key issues and develop insights from the preceding discussion of how human minds and society perceive elements of time (especially the future) in relation to climate change. This includes contextualizing temporal perceptions of climate change within existing social structures for considering the future.

People have a major interest in looking into the future, yet they also have difficulty doing so. Our ancient brains and societal perspectives (both longstanding and modern) are not well suited to the timescales and time lags of climate change. In many modern cultures, psychological and social influences work together to prioritize the short-term and in multiple ways to distance us from far-reaching consequences, even though these may be scientifically or pragmatically anticipated.

If people do look into the future, they tend to believe good things will happen to them and their families and communities. Future outcomes loom less large than immediate outcomes and are thought about in abstract, generic terms as opposed to immediate issues that are thought about in great detail and specificity, and for which rich images and associations already exist in memory. These processes buffer people's perceptions of climate change (and of its causes and solutions), in the absence of directly experiencing it. At the same time, societal practices and autonomous actors co-construct temporal perceptions and normative frames, exerting powerful influences on people and institutions: how we perceive time matters hugely. These processes may equally apply to communicators and decision makers in society, the media, and government; this may lead to very slow societal change and delay in implementing effective policy and action on climate change. We are likely to find when we get there that future worlds have indeed been 'colonized' and compromised by earlier social practices and actors.

Thus it seems that popular temporal perceptions of climate change, for understandable reasons, are out of sync with the emerging reality of climate change, and moreover, might be seen by some as dangerous perceptual disconnects or even misperceptions. There is a conundrum here: people generally view climate change as long-term and slow, while important features of social life, such as economic relationships and our use of technologies, are increasingly structured by intensification and thus geared to immediate signals and short-term actions; in fact, it is actually very late in terms of action to slow or stop irreversible and accelerating climate change, and it is society that is moving very slowly.

Such 'mismatches' raise the question of approaches available to inform and engage people in understanding the temporal implications of climate change. Currently, there are few decision-making or planning processes that help us as a society to think systematically about the future and face up to the challenges of climate change (though some mechanisms exist for planning for emergencies such as environmental and social catastrophes, and the IPCC process aims to engage at the global level). In some places comprehensive Environmental Impact Assessments of alternative future choices are undertaken (under programs such as the US National Environmental Protection Act, 1969) and these are starting to build in long-term climate change interactions.<sup>89</sup> However, these studies usually remain the domain of experts, lying outside the mainstream of most people's experience. More conventional city, regional and resource planning, intended to map out future

desired conditions for communities, often presume a steady-state and fail to address climate change issues systematically.<sup>17</sup> Planning and public involvement methods are only now adapting to the reality of climate change,<sup>90</sup> but may be unengaging to many in society and tend to be poorly attended. Thus, we currently have inadequate mechanisms for organizing wider society for a changing and uncertain future.

Much of the research reviewed above has focused on temporal perceptions in individuals, with decision on outcomes that affect only themselves. Less is known about the way in which people negotiate time scales in groups and communities and how this affects decisions about collective outcomes. Little is also known about the understanding of temporal dimensions of climate change among decision makers in particular. It is also noticeable that much psychological research has tended to focus on the flaws in human understanding and processing (e.g., in the heuristics and biases approach<sup>62,91</sup>). In line with recent commentators,<sup>15</sup> it is time to shift from this focus to a more integrative approach, exploring people's mental strengths to engage them in addressing these challenges, rather than solely attempting to turn everyone (including decision makers) into mini-scientists.

## TOWARD SOLUTIONS IN TIME PERCEPTIONS OF CLIMATE CHANGE

If the timescales of climate change are out of step with those of the human mind and the future is seen as distant and vague, future implications may become meaningful only when translated into a nearer time horizon. Humans are powerfully influenced by stories that relate to themselves and their communities, and by visual images. These mental capacities can be seen as strengths which can be used to engage people with the temporal dimensions of climate change. In a study by Nicholson-Cole<sup>92</sup> participants noted that they could not see the effects of climate change happening and therefore saw little reason to react. Participants found it easier to visualize future climate change when this related to their personal life. Similarly, Leiserowitz<sup>93</sup> states that individuals lack vivid and personally relevant images of climate change. Individuals find it difficult to see the relationship between behaviors and their consequences when there is a long delay between the two.<sup>13</sup>

Rather than presenting abstract data and projections, communicators could use more intuitive scenarios, perspective taking, narratives, and compelling visualizations to make future environmental

consequences of behavior visible, and render global processes tangible in exploring their potential local effects.<sup>17</sup> Making the invisible future visible represents a considerable advance over the simple provision of information, particularly where the agency and creativity of participants is engaged.<sup>90</sup> Other techniques include focusing on how similar others might be affected in future.

For example, Pahl and Bauer<sup>94</sup> used perspective taking with a young woman in the future to portray future health effects of environmental change in an intuitive and compelling manner. Combining a personal narrative with images of environmental impacts led participants of the same age as the narrator to seek information on pro-environmental behavior. Interestingly, the personal narrative only worked when participants literally took the perspective of the woman in the future, not if they were instructed to remain objective and concentrate on the facts.

Recent research has suggested that the issue of optimism bias could be circumvented by focusing messages around risks to other people (rather than the self), in order to avoid a defensive or denial reaction. In a health example, smokers were more inclined to accept smoking restrictions when they perceived risks to others.<sup>95</sup> Focusing on others could also work when conveying the broader positive benefits of climate action. Climate change deniers were more willing to take pro-environmental actions when these actions were framed as behaviors that will have a positive effect on others and society more broadly.<sup>96</sup> It is also possible that, compared to environmental benefits, it might be easier for individuals to relate to how mitigation efforts could benefit society. Thus, social benefits such as a more supportive and helpful community may be easier to imagine and construe with greater detail than environmental benefits such as a slowing of ocean acidification. This would be in line with the cognitive processes discussed above.

So far we have suggested two potential ways for communicating climate change risks. On the one hand, these risks could be related to a person's own experience and context if this does not pose too much of a threat. On the other hand, they could be related to impacts on similar or close others to reduce potential denial and optimism bias if outcomes are potentially very threatening.

Narrative framings of climate change may assist in expanding the frameworks through which individuals and groups interpret their temporal relationship to others, and the position of their activities within a nested set of timescapes. Kahneman (Ref 97, p. 407) suggests that 'the mind is good with stories but does not appear to be well-designed

for the processing of time'. A variety of approaches have been applied to test the value of narrative as a means of reshaping socio-temporal frameworks. The Long Now Foundation, for example, designed the Clock of the Long Now, which ticks once per year for 10,000 years.<sup>98</sup> The aim of such activities is to provide touchstones for re-imagining the relationship between present and future (as well as past) generations, and for counteracting imaginatively as well as conceptually habits of mind and emotional investments that encourage short-termism.

Other narrative approaches designed to engage emotion and imagination as a counterweight to intensification and short-termism pay close attention to the role of attachment to place and community as a tangible link with the future. The work of artists Newton and Helen Harrison, such a *Greenhouse Britain* is built around scenarios concerning the effects of rising sea levels on the Mersey Estuary and the Lea Valley in the UK.<sup>99</sup> By working over an extended period of time with local people, as well as local planners, scientists and policy-makers, the Harrisons have produced near-term science fiction scenarios that exploit local knowledge of connectedness to imagine how communities will change their ways of living in the face of climate change. Further, their work re-injects human agency into this process through dialog and collaboration, enabling people to give voice to fears and offering them the opportunity to retrieve concrete hope in the face of uncertainty. Recent academic work has used scenario narratives as one element in a participatory approach on the topic of whole energy system change.<sup>100</sup> Participants found it easiest to imagine a 'do-nothing' scenario 'where nothing had been done to address climate change and energy issues' (Ref 100, p. 41). However, alternative scenarios that were more sustainable and innovative were seen as highly desirable.

Future scenarios are an integral part of climate scientists' work but they are typically undertaken at global abstract levels and presented in the form of carbon figures and line graphs.<sup>2</sup> In many instances of scenario use, people and human impacts are not even mentioned. Scenario delivery mechanisms can be improved by using a more local and human-scaled approach, focusing on daily life and recognizable places, in current and future (before/after) conditions.<sup>101,102</sup> Scenarios can also be used to contextualize long term modeling, e.g. forest models which typically extend to two rotations (200 years). When used with realistic landscape visualizations and narratives in a local climate change 'visioning' process,<sup>101</sup> scenarios can provide a simulated but direct experience of future

climate change, framed as alternative storylines that can disclose considerable uncertainties. Sheppard<sup>17</sup> describes a range of techniques that explore temporal concepts such as time lapse sequences, 'time travel', bringing the future closer, and making it more personal. Evaluations of structured visioning processes have found effects of increased urgency and concern in public and practitioner samples, improved awareness of future implications, and increased motivation to act.<sup>90,102,103</sup> Such approaches, which help people think about the practical detail of implementing adaptation and mitigation solutions, should enhance conventional planning methods and may lead to actual policy or behavior change.<sup>104</sup> In terms of policy implications, our analysis suggests two things. First, temporally distant outcomes should be 'brought closer' to encourage consideration alongside other more immediate concerns. This could be achieved using the approaches summarized above, in a variety of contexts such as consultation exercises. Importantly, the audience in such approaches should include decision and policy makers rather than just 'the general public', because they are affected by the same temporal processes. Second, the existing time horizons within planning and policy processes should be reviewed critically to assess their suitability to issues such as climate change.

The goal of approaches of this kind is to contribute to a reshaping of the normative frameworks within social practices, and to contribute to ways in which individuals may act, as members of interest groups, communities, governmental bodies and other collectivities to change the ways they 'live' their relationship to the future. With modernity, consequentialist forms of thinking about moral reasoning and motivation became socially dominant.<sup>105</sup> Yet climate change is an issue where talking about future consequences is problematic, for all kinds of reasons, some of which we have reviewed above, and one where social practices based on calculative consequentialism may create social dynamics that intensify climate change and increase short-termism. To motivate action in the face of climate change may (paradoxically) require ethical and legal frameworks that do not focus solely on outcomes as the criteria of whether actions are right or not. Indeed, it may be necessary to focus instead on how to build individual and group capabilities, capacities and 'virtues' needed to change how the future is lived and related to.<sup>106,107</sup> From the point of view of moral philosophy, this would imply moving from moral, legal and governance frameworks informed by utilitarianism or act-consequentialism to ones based on a kind of virtue consequentialism.

## CONCLUSIONS

Climate change is long-term, delayed, with potentially rapid nonlinear changes. Individual and societal systems, on the other hand, are adapted to face-to-face interactions, and to considering short-term outcomes, immediate and linear effects. From a human mind perspective, we have argued that time is an important facet of the broader dimension of psychological distance that is deeply relevant to climate change. The challenges we are facing with climate change are complex and involve a system of interrelated societal actors and a long chain of causes, consequences, and possible human responses. However, the current dominant culture and our evolutionary history minimize the importance of long-term thinking. Rhythms are out of sync. This does not imply that people are unable to comprehend climate change, it simply means communicators need to be smarter and engage people on their own terms and capabilities.

If there is a genuine desire for an integrative negotiation of our climate change futures it is imperative to improve how we engage people and practitioners in envisioning the future, acknowledging the future implications of their current lifestyles and community choices, and getting involved in decision-making and action. At the same time, the findings from climate science will have to be made much more meaningful, compelling and engaging, if it is to integrate with everyday life and be able to compete with many other influences, while not compromising the rigor of the underlying science. Above we have listed some promising examples including better use of people-sized scenarios, perspective taking, future visualization, and narrative approaches. If opportunities are taken to employ such approaches,

we are optimistic that humankind can positively engage with and address the temporal challenges associated with climate change.

## NOTES

<sup>a</sup> Another temporal dimension concerns the *frequency* of climate change impacts. For example, extreme weather events (e.g., heat waves, heavy precipitation events) are thought to have occurred more frequently over the last 50 years and predicted to continue to increase in frequency and intensity.<sup>2</sup> A further dimension is the *duration* of effects. For example, heat waves are predicted to last longer<sup>1</sup> and the fire seasons in Canada are expected to lengthen.<sup>108</sup> Other more complex aspects of time, such as *rate of change* or *discontinuities* of climate change, are also important. We focus on future climate change and delay because these have been discussed most in the psychological and sociological literatures.

<sup>b</sup> However, social mechanisms for dealing with future adverse events have long existed in indigenous cultures, e.g. storing food for hard winters and the concept of maintaining the productivity of the land for future generations.<sup>109</sup>

<sup>c</sup> The term bias is used to describe a systematic tendency found in a majority of people without implying that this is necessarily normatively wrong.

<sup>d</sup> In one deviation to this pattern, higher perceived impact on developing countries (distant) was also related to preparedness to act, illustrating that people may be motivated through different routes, including moral impetus to look after more vulnerable others (see Section *Toward Solutions in Time Perceptions of Climate Change*).

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