Leveraging social cognition to promote effective climate change mitigation

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Effective climate change mitigation is a social dilemma: the benefits are shared collectively but the costs are often private. To solve this dilemma, we argue that we must pay close attention to the nature and workings of human cooperation. We review three social cognition mechanisms that regulate cooperation: norm detection, reputation management and fairness computation. We show that each of these cognitive mechanisms can stand in the way of pro-environmental behaviours and limit the impact of environmental policies. At the same time, the very same mechanisms can be leveraged as powerful solutions for an effective climate change mitigation.

O ver the past three decades, a number of reasons have been put forward to explain the absence of behavioural change to address climate change. Behavioural scientists have studied issues related to risk perception[1,2], misinformation[3,4], time discounting[5,6] and social identity[7], among others, to explain people's collective apathy[8]. Indeed, climate change is, in part, hard to address because it is a complex, long-term and diffused phenomenon. Yet, individual climate engagement around the world has now hit an inflection point. Today, a majority of people believe that climate change is a serious threat[9,10], that it is already happening[11], and that more should be done to curb CO_2 emissions[12–14]. Despite such increasing levels of climate change awareness, mitigation efforts have been disappointing[15]. People often fail to adopt behaviours that would be impactful, such as saving home energy or reducing air travel, even when they have access to personalized information about their carbon footprint[16]. Given the high level of concern around climate change, what other factors are keeping people from adopting behaviours or supporting policies that effectively reduce CO_2 emissions[17,18]?

Empirical evidence has shown that the social dimension of climate change mitigation partly accounts for the absence of behavioural change and offers potential solutions[19–21]. Climate change is a large-scale collective-action problem in which the outcomes are shared but the cost of behavioural change is often individual. Thus, people must resist the urge to free-ride on the sacrifices of others and so enjoy the collective benefits without making any effort. One might initially think that humans' unique capacities to cooperate provide fertile ground to address the collective-action problems posed by climate change. Yet, the cognitive mechanisms that support cooperation evolved to increase individual fitness, not to maximize total social welfare[22]. As a result, the cognitive mechanisms involved in regulating cooperation do not necessarily lead to the most effective outcome from a societal standpoint.

Evolutionary biology has demonstrated that cooperation can only evolve if it is conditional: for individuals, the only evolutionary stable strategy is to cooperate if others cooperate, and to stop cooperating when others do not cooperate[23,24]. The consequence of this constraint is that humans must develop cognitive mechanisms to detect social norms (that is, whether the norm is to cooperate in my environment), to manage their reputation (that is, to convince others that I am cooperating) and to compute what is fair and what is not (that is, to assess whether my benefits are proportionate to my contribution, and to others' contributions). In this Review, we present evidence that these three mechanisms—norm detection, reputation management and fairness computation—push people to favour reciprocity, observability and equity over effectiveness in climate change mitigation. We contrast this with the behaviour that people would adopt if they acted as 'effective altruists' (see Box 1 for a definition of effective altruism). We then show that the very same cognitive mechanisms can be leveraged to be part of the solution, as shown in Table 1. By carefully considering the social dynamics involved, policymakers can make climate change mitigation efforts more effective.

Norm detection

To contribute to a collective effort, people need to have sufficient evidence that others will also take action. In fact, people's perception of the right thing to do very much depends on what others are actually doing. Far from acting as strict moral consequentialists who maximize the positive impact of their actions, people often rely on what others believe to determine what is appropriate[25–27]. For example, although people may know that travelling by plane or eating meat is detrimental to the climate, they may continue to engage in these behaviours if they see others doing so[28]. Previous studies have shown that social norms have a large influence on people's pro-environmental behaviour[29]. Yet, social norms have also been shown to be ineffective or even to backfire in the context of pro-environmental behaviours[30–32]. Drawing on recent research, we discuss three aspects of norm detection that can be both a problem and a solution for the emergence of effective climate-friendly social norms.

Pluralistic ignorance. The costs associated with cooperating with a cheater mean that people's cheater detection mechanism functions as a smoke detector: people minimize the risk of false negatives (not detecting a cheater) while allowing more false positives to occur (mistaking a cooperative individual for a cheater)[33]. This means that people are likely to believe that others are not cooperating. This can lead to pluralistic ignorance, a situation

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Box 1 | Effective altruism

Effectiveness is often defined as the size of the impact relative to the resources used to create such an impact. Under this definition, someone spending 100 euros to avoid 1 ton of greenhouse gas emissions is more effective than another individual spending 200 euros to avoid the same amount. This concept has gained some traction, moving from the field of engineering and economics to a diversity of domains such as organization management or even charity.

The effective altruism movement was created in the late 2000s around individuals such as Toby Ord, William MacAskill and Peter Singer. This movement advocates being impartial and prioritizing causes that are great in scale, highly solvable and tractable[104]. It encourages its members to donate to charities that are effective, which leads to the largest positive impact per amount spent. It also helps people define what carrier to choose to maximize their positive impact given their skill set[105].

We define effective environmentalism as giving priority to mitigation efforts that have the most impact per amount of resources invested. For example, an individual deciding between spending 100 euros to buy organic groceries or spending 100 euros to finance a solar-powered stove in a developing country should prioritize the latter as the environmental impact will be larger. Similarly, policymakers deciding between allocating resources to providing all citizens with a composting bin or improving public transportation should prioritize the latter.

So far, the effective altruism movement has been confined to an active but small community, located mainly in the United States and the United Kingdom. For this movement to gain traction, it should take into account people's social cognition. Many studies have shown that people's intuitions often go against principles of effective altruism, such as the idea that geographic distance should not affect our willingness to help people. By taking people's psychology into account, the effective altruism movement can become more popular.

Table 1 | People's social cognition can be leveraged to promote effective climate change mitigation

Cognitive mechanism supporting cooperation	Adapted policy intervention
Norm detection	
People tend to underestimate the proportion of cooperators	Make social norms more visible
People are sensitive to the credibility of social norms	Focus on actions rather than opinions, use local community leaders to promote social norms
People only respond to norms that are already prevalent	For behaviours that are not widespread, communicate about the dynamic norm
Reputation management	
People prefer engaging in observable behaviours	Make sustainable behaviours more visible
People care about enhancing their value as cooperative partners	Align mitigation behaviours with positive traits
People are insensitive to impact when judging others' behaviour	Make the impact more direct and understandable
People judge impact maximization negatively because it is seen as too calculating	Make the most impactful behaviour the default option
Fairness computation	
People base their fairness computation on their perceived 'status quo'	Provide information to help people change their vision of the status quo
People often prefer fairness over efficiency when deciding between policies	Include redistributive programmes in policies and communicate about their impact

Cooperation between humans is supported by three cognitive mechanisms, (1) norm detection, (2) reputation management and (3) fairness computation. These cognitive mechanisms evolved to make cooperation beneficial at the individual level, which can often lead to ineffective outcomes at the collective scale. For example, people's fairness computation mechanism induces them to favour equity over effectiveness when supporting public policies. By taking into account the nature of human social cognition, policymakers can promote more effective behaviours. For example, by including redistributive programmes in policies and communicating about their impact, policymakers can gather more support for environmental policies. Whether governments have the means and motivation to implement more redistributive policies is a question beyond the scope of this Review.

in which people privately reject a norm (such as driving SUVs (sport utility vehicles)) but go along with it because they falsely assume that most others accept it. For example, Americans hold the inaccurate belief that a majority of their fellow citizens do not care much about mitigating climate change[34], and are overly pessimistic about the views of conservatives on climate change[35]. A study conducted with a representative sample in the United States suggests that part of the reason why the poorest individuals and ethnic minorities are under-represented in environmental organizations and US government environmental agencies is the widespread false belief that they are not interested in environmental protection[36]. As people are very sensitive to cheating, a few visible cheaters may also be enough to make an entire cooperative system collapse[37,38]. By identifying important areas of pluralistic ignorance, governments and other entities can promote cooperation through simple information campaigns[39,40]. However, correcting pluralistic ignorance may not be enough to change behaviour if other barriers remain[41], and as such more research is warranted in this domain.

Credibility of norms. For a social norm to be effective in promoting cooperative behaviour, people must find it credible. Credibility comes both from the source that promotes the social norm and from the content of the norm[42]. People are more sensitive to social norms when they are promoted by leaders in their community[34] or when the individuals who promote the norm have themselves adopted the behaviour. For example, a study of a programme that promotes residential solar panel installation in 58 towns in the United States found that community organizers who themselves installed panels through the programme recruited 62.8% more residents to install solar panels than community organizers who did not[43]. For governments to effectively promote social norms, they must first earn the trust of their constituents. In addition, norms about behaviours tend to be more effective than simple injunctive norms, such as telling people what most others approve of[44,45]. For example, saying that most people recycle their waste is more effective than saying that most people approve of recycling waste. Finally, in some situations norms are more effective if they do not appear as coercive[46,47]. Normative appeals that seem to limit people's freedom may have the opposite effect because of 'psychological reactance'—a negative feeling that arises from threats to one's freedom. For example, telling people to 'have fewer children, do your part' may be counterproductive. Policymakers can leverage credible sources, such as the scientific community, to promote norms, and make sure that the content of a norm is descriptive and portrays a behaviour that people willingly engage in. Finally, people are more likely to respect social norms within a group that they expect to cooperate with again in the future. The more local a social norm is, the more effective it will be[48,49].

Fig. 1 | Policymakers can leverage reputation management to promote pro-environmental behaviours by making them more observable.
In autumn 2020, the UK government implemented a green number plate policy for electric vehicles. The government argues that "the plates will make it easier for cars to be identified as zero emission vehicles, helping local authorities design and put in place new policies to incentivise people to own and drive them". This policy will also allow individuals to signal more easily their commitment to reduce their CO_2 emissions and thus improve their reputation. Contains public sector information licensed under the Open Government Licence v3.0.

Dynamic norms. People not only care about current social norms but also anticipate what will be normative in the future. Hence, they are more likely to adopt a new behaviour if they anticipate the change will persist than if they believe the change is a passing fad. Many behaviours that fuel climate change, such as driving alone, eating meat, flying or having multiple children, are currently the norm. In such cases, using normal social norm messaging will fail to promote change as the norm is, indeed, unsustainable[50]. Evidence shows that, instead, communicating about the dynamic norm—that is, the current direction of change in people's behaviour—can have a major impact[51–53]. For example, researchers have shown that by conveying to people a dynamic norm about using a reusable coffee cup rather than a disposable one ('our guests are changing their behaviour: more and more are switching from the to-go-cup to a sustainable alternative'), the proportion of consumers using reusable cups increased by 17.3% (ref. [54]). This component of people's norm detection mechanism provides a powerful tool for policymakers. However, evidence is limited to a handful of papers and further research is needed to assess the effectiveness of dynamic norms in different contexts.

Reputation management

Given the high benefit of collective actions, being perceived as a good cooperator is crucial for humans. Owing to their reputation management system, people can anticipate how others will perceive their actions and act accordingly. Having a good reputation is considered so important that people often would prefer to endure physical injury (for example, losing their dominant hand) rather than to have people believe that they are not trustworthy (for example, becoming known as a Nazi)[55]. Beyond being simply perceived as trustworthy, people compete on traits that signal their willingness or ability to confer benefits on others, such as intelligence and athleticism, but also generosity and benevolence[56]. Indeed, cooperation takes place in a competitive social market, such that people can abandon a cooperation partner in favour of another. When deciding between different options, people take into account both their direct costs and benefits and their indirect reputational costs and benefits, often without any conscious awareness of such considerations. When indirect reputational benefits are larger, people are more likely to be cooperative. For example, studies show that people

adopt more pro-environmental behaviours when such behaviours are directly observable or even when their behaviour will be known to future generations[57–59]. It is, however, important to distinguish between the ultimate advantages of having a good reputation and the proximate psychological level. Far from being Machiavellian, evidence shows that people genuinely enjoy helping others, without any conscious representation of the fitness advantage their behaviour may lead to[60]. In the following paragraphs, we detail how people manage their reputation and how it can be leveraged to promote effective climate mitigation[61].

Observability. When behaviours can be easily identified as signals of cooperation, people are more likely to engage in them. This is the case in the so-called Prius effect, by which individuals are more likely to buy a hybrid Toyota Prius rather than another electric car model as the unique design of the Prius makes it conspicuously green[62,63]. Researchers have identified that many pro-environmental behaviours have a signalling function[62,64,65]. However, many behaviours related to climate change are invisible such that reputational gains cannot take place[66]. This is true of all invisible efforts (for example, adding a layer of insulation under one's roof), private voting practices (for example, going to the polling station to support green policies) and, by definition, of abstinent choices (for example, not taking the plane or not eating beef). An obvious solution to this problem is to make pro-environmental behaviours more visible. For example, in autumn 2020, the British government adopted a new regulation that allowed all electric vehicles to have a green flash on the left hand side of the license plate (Fig. 1). This not only makes it easier for local authorities to enforce policies such as reserved parking spaces for electric vehicles but also allows people to display their green behaviour. In addition, given that governments have limited financial resources to promote mitigation behaviours, they should focus their subsidies on hard-to-observe behaviours, such as renovating one's home insulation[67].

Competence. People care a lot about enhancing their value to their social network as this will impact how they are perceived and thus whether they are chosen as a cooperation partner[68]. Appearing competent, wealthy or well connected are all potential ways to demonstrate a high value to others. However, appearing competent or wealthy can sometimes conflict with appearing pro-environmental. For example, residents in a neighbourhood might continue to water their lawn, despite calls to save water, to maintain their image as wealthy neighbours who tend to their lawn. In addition, as environmental activists have, on occasion, been associated with negative stereotypes, such as being eccentric or too militant, people may be reluctant to adopt the behaviours they promote[69]. Similarly, environmentally friendly products are associated with warmth, a trait that is not always desirable for consumers[70]. More research is warranted on the impact of aligning mitigation behaviours with traits that people value, such as openness or innovation (for example, in adopting greener modes of transportation or eating lab-grown meat).

Effort. Beyond competence, humans also care about how much effort people invest when cooperating because, all else being equal, it is better to cooperate with someone who is willing to go the extra mile. People who exert more effort to achieve a goal will therefore enjoy a better reputation[71,72]. Certain actions, such as recycling, may require daily efforts and thereby confer a positive reputation to the individual, even though the impact is quite limited. In contrast, actions that require less effort, such as taking the train instead of a plane for a short journey, may not be as socially rewarded even though the associated CO_2 emissions reduction is much larger. As a result, people may privilege effortful behaviours instead of impactful ones. By aligning effort with impact, policymakers might be able to orient citizens towards more effective mitigation behaviours.

Intentions and consequences. Evidence shows that intentions matter a lot when people judge each other's character[73]. Achieving a good outcome based on bad intentions is often perceived as worse than achieving a bad outcome based on good intentions[74]. In addition, people tend to prefer individuals who act out of empathy or who follow deontological rules, rather than consequentialist individuals who weigh the costs and benefits of every action[75]. People who deliberate more about the consequences of their charity donations, for example, are perceived as less moral and as less desirable social partners than individuals who rely more on empathy to make their choice of donations[76]. In other words, although prioritizing actual impact is good from a societal standpoint, it may come at a reputational cost. This may explain why the effective altruism movement is still confined to a small group, despite the many rational arguments that support its value. For impact to matter as much as intentions, it must be easily measured and known to people. Making the link between people's action and their environmental consequences clearer will allow people to take impact into account more easily. Once causes are linked to consequences, it is much easier to make a case for choosing the most efficacious course of action[77]. Thankfully, there has been much progress in that direction in recent years. Impact assessments have become a common practice in many areas of public policy, and even researchers have called for impact-focused environmental psychology[78]. More research should be conducted on how to encourage individuals to adopt more impactful approaches to climate change mitigation.

Fairness computation

When engaging in cooperation, people not only decide who they should cooperate with but also how the costs and benefits of cooperation should be shared. Research shows that our fairness computation mechanism evaluates the costs and benefits based on the outside options available to people, that is, the pay-off people would have enjoyed if they had decided not to cooperate with a specific partner[79]. Individuals with more valuable outside options—typically people with large social networks that include many potential trustworthy partners—are usually given a larger share of the benefits, which thus ensures that a cooperative interaction is advantageous to all parties involved. To sustain cooperation, people constantly monitor the costs and benefits accrued to others, for example, how much effort people from other countries are making to reduce CO_2 emissions[80]. This helps people identify the appropriate response, such as changing their lifestyle drastically or spending little effort on reducing emissions. This sort of computation is constantly happening in people's minds, most often beyond their conscious awareness[79]. When people feel like the cost and benefits of cooperation are not fairly distributed, they will refrain from cooperating. The allocation of costs and benefits depends on specific principles, and is often deemed more important than the aggregate outcome of cooperation. A good illustration of this is that citizens in low-income countries are less supportive of international agreements that force their country to take climate change mitigation measures than citizens in wealthier nations are and tend to think that high-income countries should make more effort to protect the environment[81]. By understanding how fairness is computed, policymakers can design mitigation policies that may gather more support.

Fairness depends on the perceived status quo. The fair allocation of costs and benefits to individuals who are cooperating depends on the perceived status quo. Indeed, costs and benefits are calculated according to a given baseline, which includes the outside options of each individual[82]. People who have different perceptions of the status quo may have a hard time agreeing on what constitutes a fair outcome. Perhaps the most dramatic instance in which status quo perception matters is for a country's pledge to reduce CO_2 emissions[83]. If people consider that the status quo is the current

Box 2 | The case of meat eating

Reducing meat consumption represents a major opportunity to mitigate climate change[106] with 14.5% of all anthropogenic greenhouse gas emissions coming from the livestock sector[107]. In addition, there are few structural barriers to adopting a plant-based diet. Such a diet is not only often cheaper but also nutritionally adequate, and may provide health benefits for the prevention and treatment of certain diseases[108], and plant-based alternatives are easily accessible in most developed economies. Some informational barriers may still be an obstacle to adopting a plant-based diet, such as the belief that eating meat is important to stay healthy[109] or a lack of information regarding the environmental footprint of meat. Yet, many people frequently eat meat even though they are well aware of the negative impacts of these behaviours and have the means to make different choices[16].

Taking into account people's social psychology is essential to encourage them to reduce their meat consumption[110]. Wyker and Davison showed that normative beliefs about the extent to which friends, family and colleagues believe one should follow a plant-based diet are strong predictors of intentions to do so[111]. People may suffer from pluralistic ignorance on the issue of reducing meat consumption. Although many people may privately believe that reducing meat consumption is important to mitigate climate change, they may hold the false belief that a majority of people would disagree with them. In addition, eating meat is the current norm, which offers little social pressure for people to change their behaviour[112]. However, as Sparkman and co-workers showed in multiple experiments, when given information about the dynamic norm—that is, the increase in the number of people switching to vegetarian diets—people are more willing to select vegetarian options[51,52]. From a reputation management perspective, reducing meat consumption raises two issues. First, people's dietary choices are hard to observe, which creates little incentive for people to reduce their meat consumption, for example, when eating at home. Second, eating less meat may conflict with other aspects of one's reputation, such as appearing like a generous host[113]. As a result, people may gain little reputational benefits from adopting a vegetarian diet. By making dietary choices more conspicuous and by aligning people's values with plant-based diets, policymakers and companies can encourage people to reduce their meat consumption. Finally, equity concerns may also impact people's dietary choices. People may perceive the reduction in meat consumption as an unfair cost placed on meat producers. Policymakers should thus ensure that no segment of the population is unfairly affected by such dietary changes.

emissions level, then all countries should make commitments proportional to their current emissions and to their ability to mitigate them[84]. However, if people consider that the appropriate baseline is the status quo ante, which corresponds to the state of the world before the Industrial Revolution, then Western countries, such as the United States, Canada, the United Kingdom or members of the European Union, who have already contributed to more than 50% of the global cumulative CO_2 emissions, should compensate this disproportionate historical contribution to climate change[85]. Status quo considerations may also affect more local decisions, such as how to allocate public space between drivers, pedestrians and bicycles. If one considers that the baseline is that streets are primarily designed for cars, then any policy to increase bicycle lanes will be seen as a loss for car drivers. However, if one considers that the relevant baseline situation is one in which cities are built for all people and not just car drivers, then such policies will be construed as claiming

back what rightfully belongs to pedestrians and cyclists. Changing our frame of reference can impact how we see the world[86–88]. More research is needed on the influence of the perceived status quo on support for environmental policies.

Fairness over effectiveness. People often value fairness above and beyond the aggregate outcome of a given action. In other words, people's sense of fairness does not follow consequentialist principles, which favour 'the most good for the most people'. For example, a majority of people are unwilling to increase cure rates for a large group if it comes at the cost of reducing cure rates for a smaller group[89]. Additional examples include that most people will favour income distributions that are more equal rather than those with a higher total income[90]; prefer retributive justice (in which the punishment is proportional to the crime) to deterrence, even though basing punishments on deterrence leads to lower crime rates than basing punishments on retribution[91]; and condemn pushing one person off a footbridge to stop a trolley from killing five people further down the tracks[92]. When individuals must decide between different environmental policies, they will favour fairness as much as effectiveness[93–95]. Policies that are seen as unfair have very little chance of success, as the recent example of the 'Yellow Vest' movement in France has shown[96,97]. The movement started after the government announced a new tax on carbon that would lead to increases in gas prices (which would predominantly affect poorer rural communities who commute by car to work), without impacting kerosene prices (which would affect richer individuals who travel by plane). If policymakers are to gain support for far-reaching regulations, such as a universal carbon tax, they will need to consider the perceived fairness by the general population[98,99].

Outstanding questions

Our Review highlights a critical need for further research on at least three fronts. First, more research should be done on the dynamic component of social norms. Experiments should be conducted to identify how new social norms can emerge rapidly in a group and how to use network analyses to target individuals who will accelerate the adoption of the norm. By understanding the dynamics of social norms, we can steer groups towards reaching a moral tipping point—a threshold beyond which it will become a moral obligation to adopt environmentally virtuous behaviours[100,101]. Second, more research should be done around the promotion of effectiveness as a moral standard. To mitigate global warming, people will not only need to change their behaviour but also have to systematically adopt those behaviours that are most effective at reducing their carbon footprint. Making people adopt an 'effective environmentalist mindset' is a central issue for climate change mitigation. Finally, as many economists and climatologists have argued, large-scale policies, such as a carbon tax, are essential tools for an effective climate change mitigation design. As such, further research on the acceptability of these policies and the factors that influence perceived fairness is crucial. In addition, most studies cited in this Review were conducted on Western subjects. Although Western countries produce the most per capita CO_2 (ref. [102]), more research should be done in other populations to determine whether the results are generalizable.

Accelerating sustainable transitions

Cooperation is supported by dedicated cognitive mechanisms and can be seen as an adaptation to solve humans' collective action problems. By detecting social norms, managing their reputation and computing what is fair, people ensure that they benefit from cooperative endeavours. Climate change is a perfect example of a social dilemma in which people's social cognition plays a large role. The cognitive mechanisms that support cooperation ensure that mitigation efforts are aligned with people's interests. If certain criteria

are not met—such as observability or fairness—then the adaptive response will be to refrain from cooperating. A deeper understanding of people's social cognition can allow us to remove some barriers to effective climate change mitigation. For example, social cognition can be leveraged to reduce people's meat consumption and associated greenhouse gas emissions, as discussed in Box 2. Adding social motivation to the tools for promoting pro-environmental behaviours seems crucial given the urgency of the climate crisis. In addition, understanding people's social cognition can help make sense of seemingly unrelated behaviours. Indeed, biases in how people process information—for example, believing or not believing the scientific evidence for climate change—may be a symptom of underlying social motivations[7,41,103]. Understanding people's attitude towards climate change mitigation is therefore inseparable from understanding people's social cognition.

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