Human Cooperation and the Crises of
Climate Change, COVID-19, and Misinformation

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Abstract

Contemporary society is facing many pressing challenges, including climate change, Covid-19, and misinformation. Here we illustrate how these three crises are each social dilemmas, characterized by a conflict between short-term self-interest and longer-term collective interest. The climate crisis requires paying costs today to benefit distant others in the future. The Covid-19 crisis requires the less vulnerable to pay costs to benefit the more vulnerable, in the face of great uncertainty. The misinformation crisis requires investing effort to assess truth, as well as resisting the temptation to spread attractive falsehoods. Addressing these crises therefore requires understanding human cooperation. To that end, we present (i) a brief overview of mechanisms for the evolution of cooperation, including mechanisms based on similarity (i.e., kinship, spatial selection, and group selection) and those based on interaction (i.e., direct reciprocity, reputation); (ii) a detailed discussion of how reputation can incentivize cooperation via conditional cooperation and signaling; and (iii) a review of social preferences that undergird the proximate psychology of cooperation, including positive regard for others (i.e., a cooperative orientation to others in general), parochialism (i.e., a cooperative orientation to ingroups, sometimes at a cost to outgroups or the collective as a whole), and egalitarianism (i.e., an orientation that seeks to reduce absolute differences in outcomes for self and others). We then discuss each of the three focal crises facing our society through the lens of cooperation, emphasizing how insights from cooperation research can inform efforts to address these crises.

Keywords: Climate change, Covid-19, human cooperation, misinformation, reputation, social preferences

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INTRODUCTION

The world is faced with many *cooperation* challenges. When writing this article, in the winter of 2020-2021, the most immediate crisis is COVID-19. People were asked to comply with strict rules during a lockdown, often working from home, and when outside keeping physical distance from other people (e.g., Van Bavel et al., 2020; Zhang, Tao, Shen, Fairley, & Guo, 2020). A more “creeping” challenge is the climate change crisis, one that started in the 1970s when people saw early signs of global warming. It took some time before a majority of people fully realized that global warming is partially due to human behavior, necessitating major changes in our consumption patterns (e.g., Gifford, 2011; Van Lange et al. 2018). And finally, there is the misinformation crisis, often called “fake news”, which has existed in some form for centuries but has recently been thrust into the public consciousness by social media and blatant lies from political elites (e.g., Lazer et al., 2018; Pennycook & Rand, 2021). Clearly, the three crises look very different, and *are* very different. They differ not only in their history and urgency, but also in concreteness and reversibility. Climate change seems abstract yet has largely irreversible consequences, whereas COVID-19 is very concrete and largely reversible, even if it may come back in a slight different form – and the misinformation crisis will never really disappear but can dampened by immediate action.

To illuminate these crises, we will review empirical research on human cooperation. This represents a broad topic in the scientific literature and is addressed in a variety of disciplines, including not only the social and behavioral sciences, but also biology, climate science, and mathematics (e.g., Rand & Nowak 2013; Van Lange et al. 2013). Accordingly, we see an increasing cross-fertilization in research activities and theories developed across various disciplines (e.g., Henrich & Muthukrishna, 2021; Van Dijk & De Dreu, 2021). While our focus is largely psychological, we will draw upon some key insights from evolutionary science, economics, and political science. In so doing, our article builds on two recent *Annual*

Review of Psychology articles. While Van Dijk and De Dreu (2021) provide an in-depth analysis of economic games to understand the motives and strategies in different mixed-motive situations, we focus on social dilemmas and human cooperation reviewing within and beyond the context of economic games. And while Henrich and Muthukrishna (2021) provided an expanded evolutionary analysis of human cooperation to understand pronounced differences among societies, we focus on classic evolutionary and psychological accounts of human cooperation, and how it might illuminate specific societal crises that challenge our modern world.

We seek to accomplish two broad goals. The first is to provide a review of the basic science of human cooperation. In doing so, we briefly unpack the puzzle of why people evolved as a cooperative species (evolution of cooperation, Nowak 2006; Rand & Nowak, 2013), we discuss in greater depth how and why we are so concerned about what others think of us and why this may promote cooperation (reputation), and how exactly human preferences are different from - and extend - self-interest (social preferences). We focus our attention on these topics not only because they received enormous attention in research over the past decade, but also because they follow from an evolutionary and psychological approach to human cooperation. Thus, we provide a focused rather than a comprehensive review of social dilemmas and human cooperation.

The second goal is to provide an introduction to the emerging literatures on the three cooperation crises with which we began this piece: climate change, COVID-19, and misinformation. Rather than providing a comprehensive review of each topic, we discuss these crises from the perspective of human cooperation, thereby focusing on recent research over the past 5-10 years on climate change, and even more recent research on COVID-19 and misinformation. In doing so, we hope to help meet a longstanding promise of this interdisciplinary literature: that key insights obtained from research in economic games,

social dilemmas, and complementary cooperative decision-making situations may help address societal challenges facing the world.

KEY APPROACHES

Origins of cooperation

How did human cooperation arise in the first place? Given the fundamentally selfish logic of natural selection and “survival of the fittest,” it may seem surprising that cooperation exists at all. A large body of research across the social and natural sciences has thus sought to explain the evolution of cooperation. This work has mostly involved formal mathematical and computational models using the language of game theory to describe social dilemmas. The models typically apply equally well to a wide range of organisms, and to cultural evolution (e.g. social learning) as well as biological evolution – although research among social and behavioral scientists has largely focused on human cooperation (for a review, see Rand & Nowak 2013; Van Lange et al., 2013). Sidebar 1 provides more information about the concept of social dilemmas.

In particular, the Prisoner’s Dilemma captures the social dilemma of cooperation. Two players simultaneously decide whether to cooperate or defect. If both cooperate, they both earn more than if both defect – but the highest payoff comes from cooperating while your partner defects, and the lowest payoff comes from defecting when your partner cooperates (a common parametrization of the Prisoner’s Dilemma is to define defection as taking no action while cooperation entails paying a cost to give a greater benefit to the other person). Despite the collective benefit of mutual cooperation, the individual earns more by defecting regardless of what the other player chooses. As a result, natural selection favors defection in the Prisoner’s Dilemma, which sets up the puzzle of the evolution of cooperation.

This game theoretic framework has been used to demonstrate numerous ways in which cooperation can be favored by natural selection and spread through populations. Table 1 provides an overview of five mechanisms, including kin selection, spatial selection, group selection, direct reciprocity, and reputation (Nowak 2006). At the most basic level, there is *kin selection* (Hamilton 1964). The logic of kin selection is that the unit of reproduction is not the individual, but rather the gene. Therefore, selection can favor a gene that induces the organism to cooperate with other organisms that also hold that gene.

A similar concept is *spatial selection* (Ohtsuki & Iwasa, 2006). When populations are structured by social networks, assortment can arise whereby neighboring individuals have similar strategies – such that cooperators are more likely to receive the benefits of others’ cooperation, and this assortment allows the survival and spread of cooperation.

A third mechanism, *group selection* (or multi-level selection), involves populations split into separate groups (van Veelen 2009). Even though defectors will outcompete cooperators within a group, a group made entirely of cooperators will outcompete a group made entirely of defectors. Thus, if groups are sufficiently impermeable (such that defectors are unlikely to arise in or enter groups of cooperators), cooperation can spread. These three mechanisms all fundamentally rely on *similarity* between interaction partners (also called “assortment”).

The remaining two mechanisms are fundamentally different, and instead operate via people’s ability to *condition* their behavior towards other on the others’ past actions. In *direct reciprocity*, players interact repeatedly with each other. Such repeated interaction creates within-relationship reputation, and allows the success of strategies that only cooperate if their partners are also cooperative (e.g. “tit-for-tat”; Axelrod 1984).

Finally, there are strategies that involve more general *reputation* effects, where interactions happen within a social group – and therefore affect the players’ reputations which are carried forward to future interaction partners. This allows *indirect reciprocity*,

where players must cooperate with those in good reputation in order to maintain their own reputations (Ohtsuki & Iwasa 2006); and the use of cooperation to *signal* that one would be a good partner (e.g., professional, romantic) (Gintis et al. 2001).

Reputation

While each of these mechanisms can allow for the evolution of cooperation, it seems likely that those involving reputation are particularly central to the cooperation between non-kin that forms the fabric of modern human societies (Rand & Nowak 2013). Reputation is a central feature of human social life, playing a key role in supporting human cooperation. The essence of reputation-based cooperation is that when others know about your past actions – for example by direct observation, or via gossip – how they act towards you may depend on how you acted previously. This can make it worthwhile for you to cooperate in two fundamentally different ways: conditional cooperation and signaling.

Conditional cooperation. In *conditional* cooperation (often referred to as reciprocity), you need to cooperate today in order to receive the benefit of others cooperating with you in the future. Specifically, successful conditional strategies will only cooperate with partners who are in good reputational standing (the definition of which varies across contexts and strategies). If enough other people are playing such conditional strategies, then it becomes worth it for you to incur costs to earn a good reputation – and therefore receive the benefits of others cooperating with you. Social norms determine what is required to earn a good reputation. Although there are an infinite number of social norms that successfully incentivize cooperation, all such norms must (i) require cooperating with a partner who is in good reputation, and (ii) allow non-cooperation with a partner who is in bad reputation (Balliet et al. 2021; Ohtsuki & Iwasa 2006). Under such conditions, cooperation can be sustainable (i.e., is a Nash equilibrium) and be favored by evolution: The “shadow of the

future” can make cooperation the advantageous choice today (provided that your actions are sufficiently likely to be known in future interactions).

Accordingly, a wealth of behavioral experiments – mostly using incentivized economic games – have demonstrated that the possibility of conditional behavior promotes cooperation. When two players interact repeatedly, they typically learn to cooperate if the probability of subsequent interaction is sufficiently high relative to the game payoffs (Rand & Nowak 2013). Analysis of game play suggests that most players use simple cooperative strategies like tit-for-tat or “always defect” (Dal Bó & Frechette 2011), although participants are also able to maintain cooperation with the presence of noise or errors by using more complicated strategies that are (somewhat) forgiving or generous (Fudenberg et al. 2012; Rand et al. 2015; Van Lange et al. 2002).

Cooperation in repeated group-level social dilemmas is more challenging than repeated dyadic cooperation. For example, consider a Public Goods Game (PGG) in which 4 players simultaneously decide how much money to keep for themselves versus contributing to a group project. All contributions are doubled and split equally – so the group does best overall if everyone contributes, but each player individually loses money when contributing. In repeated PPGs, cooperation routinely decreases over time because targeted reciprocity is not possible – either you cooperate with everyone or no one (Hardin 1968). However, group cooperation can be stabilized by making people’s contributions to the public good observable. This allows PGG cooperation to be coupled to dyadic interactions: If people know how much others contributed to the group, this allows them to hold other group members accountable for failing to contribute to the PGG by punishing them in pairwise interactions (e.g., by withholding cooperation, Milinski et al. 2002, Rand et al. 2009, Willer 2009; or engaging in costly punishment, Fehr & Gächter, 2000). In other words, subjects

typically abide by a social norm that requires not just cooperating with one's partner (as in tit-for-tat) but also contributing to the welfare of the group.

This logic even extends to large groups where most players do not have pairwise interactions with each other – as long as *some* pairwise interactions exist for each player, everyone can be held accountable. For example, Hauser and colleagues found stable cooperation in a repeated 1000-person PGG in which each subject also played a repeated dyadic Prisoner's Dilemma with one other group member (Hauser et al. 2016). The power of observability to promote public goods has also been demonstrated outside of the lab. For example, Yoeli and colleagues tripled participation in a blackout prevention program ("demand response" where the utility company turns down air conditioning intensity on hot days) by having residents enroll using publicly posted sign-up sheets (Yoeli et al. 2013).

Furthermore, reciprocity can stabilize cooperation in situations where any given dyad only interacts once, but people carry reputations from interaction to interaction. Social norms that require cooperating with those in good reputation in order to maintain one's own reputation create incentives for cooperation. Accordingly, many experiments have shown that providing reputation information promotes cooperation in one-off interactions (Bolton et al. 2005; Sommerfeld et al. 2007; Wedekind & Milinski 2000). Furthermore, people explicitly understand the value of a good reputation, as shown in an experiment where participants could buy and sell reputations in between rounds of cooperation games (Pfeiffer et al. 2012), as well as in experiments in which participants know that others can share reputational information with other participants with whom they become interdependent later on (e.g., Wu et al. 2016a).

More generally, people respond very strongly to possibility of others sharing reputational information through gossip. There is even research showing that, under some circumstances,

gossip can promote cooperation as effectively as classic forms of punishment. Because gossip includes no costs (unlike punishment), the possibility for participants to gossip may well be at least as efficient as the possibility for participants to punish (e.g., Wu et al. 2016b) which may help explain the prevalence of gossip in everyday life (Eriksson et al. 2021). Moreover, such findings are a nice complement to the earlier-described finding from field research showing that cues as small as writing your name on a form can promote donations in a very effective manner (Yoeli et al. 2013). Hence, the power of conditional cooperation-based reputation helps stabilize cooperation in a variety of situations.

Signaling promotes cooperation. The other way in which reputation can promote cooperation is through *signaling*. Under the logic of signaling, you cooperate as a way to attract new partners – that is, your cooperation acts as a signaling that others will benefit from interacting with you in the future. The cost you pay to cooperate is then offset by the benefit you receive from being selected as a partner. There are numerous different forms of signaling, each of which can promote cooperation.

A particularly widely studied form of signaling is *costly signaling*. Costly signaling requires cooperation to be less costly for people who would be desirable partners than for people who would be undesirable partners. If so, then cooperation can function as a costly signal if the cost of cooperation for desirable partners is less than the benefit of being chosen as a partner (such that cooperation is net beneficial for desirable partners) but the cost of cooperation for undesirable partners is more than the benefit of being chosen (and thus net costly). Under these circumstances, it is only worthwhile (i.e. payoff-maximizing) for desirable partners to send the signal, making the signal reliable (Gintis et al. 2001). For example, consider wealth signaling. Cooperation is less costly for people who are wealthier, and thus can serve as a costly signal when people are trying to select wealthy partners. By spending money on cooperation, wealthy people can credibly signal their wealth (because

less wealthy people would be unable to afford it). Or consider signaling one's altruism. Cooperation is less (psychologically) costly for people who are more altruistic, because the material cost is offset by a psychological benefit. Thus, when people are trying to select altruistic partners (e.g. in the context of romantic partner choice), cooperation that is sufficiently costly may credibly signal one's altruism. The logic of costly signaling can also be extended to the punishment of selfish behavior (and the expression of moral outrage), which can function as costly signals of cooperativeness (Barclay 2006; Jordan et al. 2016a; Jordan & Rand 2020).

A second form of signaling involves credibly signaling that you will cooperate in the future. Here, cooperation is not the signal itself, but rather the outcome which is being signaled. For example, one's past cooperation can act as a signal that one will cooperate in the future, which leads to increased trust (Manapat et al. 2013; Manapat & Rand 2012) and more interaction partners (Barclay & Willer 2006; Rand et al. 2011; Shinado et al. 2013). In a third form of signaling, features of one's decision *process* can signal cooperativeness. For example, people expect decisions that rely on emotion to be more cooperative than decisions that rely on reason, and thus cooperate more with emotional deciders (Levine et al. 2018). And choosing to cooperate more quickly or without examining the costs can signal a willingness to cooperate across contexts, leading such deciders to be trusted more by subsequent interaction partners (Jordan et al. 2016b).

Regard for Others

While reputation effects can make it self-interested to cooperate, a key question that has been central in research on human cooperation is: Are people's preferences broader than the pursuit of self-interest – will they cooperate even when it is not self-interested to do so? As demonstrated by work using the terms “social preferences” (e.g., Fishbacher & Gächter

2010), social value orientation (e.g., Van Lange 1999), or cooperative phenotypes (e.g., Peysakhovich et al. 2014), the answer is “yes”, even for complete strangers. Recent research has made considerable progress and suggests the importance of at least three broad prosocial preferences: positive regard for others, positive regard for ingroups (parochialism), and positive regard for equality (egalitarianism).

Positive regard for others (universal cooperation). Are most people prone to approach strangers cooperatively? This question has been addressed in so-called *single-trial social dilemmas* in which two people simultaneously choose how much money to send to each other, knowing that any money transferred is increased by some multiplier. In these situations, typically most people choose to send some or all of their money. Much research on the so-called dictator game reinforces these findings. A typical dictator game is like the paradigm described above, except just one person faces the decision of how much money to give to another person (with no multiplier on transfers), while the other person makes no decision. In this unilateral giving situation, a meta-analysis of 616 studies found that the average level of giving is around 28% (Engel 2011). It is also of interest to note that only in six of the 616 studies (1%) did all of the participants keep all the money, the prediction that would follow from a (material) self-interest perspective.

Another line of research has focused on a new construct, called social mindfulness (Van Doesum et al. 2013). While social dilemmas and the dictator game focus on material outcomes, social mindfulness captures the notion of leaving choice (or options) for another person, thereby bringing to the forefront low-cost cooperation – or what many people might call kindness. As an illustration, imagine that there are two flavors of yogurt, cherry and strawberry, but there is only one cherry left at a hotel breakfast. A guest might take the last cherry yogurt, but that would deprive anybody who comes later of a choice. The socially mindful option would be to leave the last cherry and pick something else – even if they

preferred cherry themselves. The social mindfulness construct has been operationalized as “making other-regarding choices involving both skill and will to act mindfully by leaving (rather than limiting) choice for another person” (Van Doesum et al. 2013).

In some studies, the average level of social mindfulness with strangers was about 65-70% among adults (Van Doesum et al. 2013; Van Doesum et al. 2019). Further, if people believe that there is no second chooser, the percentage of people choosing the non-unique item is 52%, whereas a large majority (78%) choose the non-unique item when that choice affects the option for a second person that is present – a clear example that it is social mindfulness rather than a simple preference for a non-unique (or unique) object that guides this decision (Van Doesum et al. 2018a). Research on social mindfulness has yielded a wealth of findings. For example, people exhibit greater social mindfulness with others that have trustworthy (versus untrustworthy) faces (Van Doesum et al. 2013), with people than with robots (Nijssen et al. 2020), and with people from lower (versus higher) social classes (Van Doesum et al. 2018b). Also, there is good deal of cross-national variation in social mindfulness, even in western societies (Van Doesum et al., 2021). Interestingly, societies that are more socially mindful are also more likely to invest in a sustainable environment.

While we have discussed laboratory or related studies above, there is also a good deal of evidence that people are other-regarding toward strangers in other contexts (Van Lange & Columbus 2021). For example, experimental studies in which people are instructed to greet, smile, or initiate a very brief conversation in everyday life – a *single* encounter – uncovered that such friendly behaviors yield friendliness in return and even boost people’s happiness. Such benefits have been found in interactions with a bus driver, the person selling cappuccino at the coffee shop, or simply the fellow participant waiting to take part in an experiment (e.g., Epley & Schroeder 2014; Gunaydin et al. 2020). But positive regard for others can also be extended to costly helping of strangers in need and can be reflected in universal cooperation,

a general tendency to make a contribution to serve collective interest at some cost to self. For example, many people recycle, bring back lost wallets, and some even clean parks (e.g., Cohn et al. 2019; see also Henrich & Muthukrishna 2021).

Positive regard for ingroups (parochialism). One of the most classic and robust phenomena in research on intergroup relations is ingroup favoritism (Tajfel & Turner 1979). People have a strong tendency to allocate greater resources – points, money – to their own group than to the outgroup, even when the basis for ingroup versus outgroup categorizations is trivial, such as preferences for painters or randomly determined (Brewer 1999; Ellemers & De Gilder 2021). In the human cooperation literature, the positive regard for one's own group has been termed parochial (ingroup) cooperation, and this has been contrasted with universal cooperation: the positive regard for the entire collective, including the ingroup and outgroups (e.g., Aaldering et al. 2020; Van Dijk & De Dreu 2021).

Several intriguing questions have been raised. One is whether ingroup love is stronger than outgroup hate. By developing specific economic games to disentangle these two motives, several experiments have uncovered that a positive regard for the outcomes of the ingroup is stronger than a negative regard for the outgroup (e.g., Halevy et al. 2012). Subsequent research has replicated this finding, and provided some evidence for the notion that parochial cooperation is often stronger than universal cooperation – a finding that is consistent with various evolutionary mechanisms, as ingroup members are more likely to be relatives, to share similar strategies, and to be future interaction partners. Psychologically, the dominant explanations derive from shared social identities or ingroup-based trust (e.g., Tajfel & Turner 1986; Yamagishi et al. 1999).

But equally important, the motives underlying parochial cooperation are substantially different from those underlying universal cooperation, as shown by Aaldering and Böhm

(2020, Study 3). Three findings stand out. Social dominance orientation, or a preference or tendency to see hierarchical structure in groups (Sidanius & Pratto 2012; see also Ho et al. 2015), is predictive of stronger parochialism (positive concern with ingroup coupled with hostile outlook at outgroups). In contrast, empathic concern is predictive of cooperation with the ingroup (weak parochialism) *without* hostility towards an outgroup. And a concern with equality (to be discussed next) seems a key predictors of universal cooperation (Aaldering & Böhm 2020). We conclude from this, and other research, that parochial cooperation – a positive regard for the ingroup – is often a strong motive with psychological roots in empathy, shared identity, and ingroup-based trust (e.g., Bloom 2016; Ellemers & De Gilder 2021; Yamagishi et al. 1991). At the same time, various other circumstances may enhance parochial cooperation through these three mechanisms (e.g., a perceived threat from outgroups, or a history of hostility and conflicts), which may undermine universal cooperation. Yet, the precise circumstances under which parochial cooperation poses serious threats to universal cooperation has yet to be determined, as recent research has uncovered the reverse as well: that parochial cooperation will decline when it is associated with harm to outgroups or the collective (e.g., Aaldering et al. 2018). And recent research on economic games demonstrated that empathy for refugees can be an important way to promote outgroup help (Böhm et al. 2018).

Positive regard for equality (egalitarianism). Most people have a tendency to appreciate equality in outcomes, and especially to dislike inequality in outcomes (Fehr & Schmidt 1999; Van Lange 1999). While it is well-known that inequality in one's own advantage is less aversive than inequality to one's disadvantage, the general tendency for egalitarianism, or inequity aversion, is ubiquitous. A substantial number of people (close to 20%) give away *exactly* half of the endowment to another person in the dictator game, and in some nonwestern societies the equal split is even the most frequently chosen option (Engel,

2011). Egalitarianism is quite basic, and has been shown to gradually develop in children in between 3 and 8 years old (e.g., Fehr et al. 2008). Egalitarianism may play an important role even in situations where material outcomes do not directly matter. Research shows that many people value equality in receiving “voice” in decision-making procedures: If the supervisor asks my opinion, he or she should be asking other’s opinions as well (Van Prooijen et al. 2012).

Numerous behavioural studies have shown that people are quite prepared to pay cash if they can restore equality in outcomes by doing so. Indeed, the desire for egalitarianism is also supported in research on third-party punishment, when the observers do not in any way benefit themselves from punishing norm violators (Fehr & Fischbacher 2004; for a meta-analysis, see Balliet et al. 2011). People derive some pleasure from seeing exploitative individuals receiving a punishment (e.g., Singer & Steinbess 2009), and young children and even chimpanzees are willing to incur costs to continue watching an episode in which an antisocial actor receives punishment (Mendes et al. 2018). Taken together, egalitarianism is a strong tendency among humans.

THREE SOCIETAL CHALLENGES

The Climate Change Crisis

Climate change can be regarded as one of the most complex social dilemmas imaginable. To simply state that it is a conflict between short-term self-interest and long-term collective interest does not do justice to the complexity, and especially the abstractness, of this particular social dilemma (Gifford 2011; Van Lange et al. 2018). Generally, abstractness is a problem because, as we will see, abstractness readily translates into *psychological distance*, a cognitive state or construal whereby people tend to orient themselves to practical matters in the here and now, while considering ideals for the future (e.g., Gilead et al. 2020). For

example, consider the impact of flying by plane on the climate. Flying is often practical as it “saves time” (and often saves money as well), and thus is more feasible than travelling by train (or bus). But it is difficult to envision the ecological consequences of flying for the climate, and thus how detrimental flying exactly is for one’s own country, let alone other countries, the continent, or the world. Therefore, abstractness and psychological distance pose an enormous challenge to attaining and sustaining cooperation in climate change. The abstractness of climate change derives from at least three sources of distance (Van Lange et al. 2018; Huckelba & Van Lange 2020): Distance in time, distance from the self, and distance from the ingroup.

Distance in time. Climate change involves *distance in time*, as people’s actions now can have effects that only become visible decades from now. And some of the climate change effects we face now, such as increased temperature and unpredictable weather, are likely the result of human behavior four or five decades ago -- when people in many western countries increasingly used cars, flew by plane, and ate meat (to name only three of the many sources of increased CO₂ emissions). This helps explain the finding that out of a variety of personality traits, it is individual differences in consideration of future consequences that are a key predictor of sustainable behaviors, such as commuting in an environmentally-friendly manner if the opportunities are available (e.g., Joireman et al. 2004). Further, there is an abundance of research on temporal discounting (or time discounting) showing that individuals and groups value rewards in the future less strongly than rewards in the present or short-term (e.g., Jacket et al. 2013). While COVID has urgency because risks for the collective and the self are in the very near future (or even in the here and now), climate change lacks such urgency. Or as Weber (2006, p. 103) stated it: “the time-delayed, abstract, and often statistical nature of the risks of global warming does not evoke strong visceral reactions.”

But that is not the whole story for climate change. An additional complexity is that in the context of climate change, outcomes in the future are often associated with much more *uncertainty* than outcomes in the here and now, or even in the near future (e.g., the next week). This is often (but by no means always) inherently related to distance in time. Relative to immediate outcomes, outcomes in the future are more uncertain, as there may be unforeseen developments or events that might mitigate (e.g., technological innovation) or magnify (e.g., underestimation of effects in the future) climate change. Also, the spread of misinformation is especially likely to cause uncertainty for general, longer-term consequences (Van der Linden et al. 2017). Moreover, uncertainty regarding outcomes in the future is often associated with a decrease in perceived (behavioral) efficacy. That is, given a good deal of uncertainty, it becomes hard to estimate how much one's actions now help reduce climate change in the future. Indeed, considerable research has shown that a lack of perceived efficacy is a key deterrent of cooperation, but also that it sometimes is used as a self-serving excuse to justify one's lack of cooperation (Kerr 1992; see also Gifford 2011). The role of perceived efficacy has also been demonstrated in recent research on support for organizational effectiveness to help reduce climate change (O'Connor & Keil 2017). Thus, some doubt regarding one's own efficacy, or one group's efficacy, can seriously undermine contributions to a sustainable world.

Distance from the self. Climate change also involves *distance from the self*, as the collective is an abstract entity, such as our continent, or even more accurately: the world. Rather than a small cohesive group with whom one interacts face-to-face, the effects of individuals' actions impact larger collectives, without geographical boundaries, up to the point that it may concern our entire planet. Distance from the self is important, because as groups are bigger and more abstract, people often feel less responsible for collective

outcomes, identify less strongly with the group, feel less efficacious, and often are somewhat less able to reap reputational benefits (Van Lange et al. 2013).

Research on social dilemmas has devoted some attention to group size. However, this research often focuses on group size effects in small groups. One robust finding is that dyads are more cooperative than groups of three or larger. A somewhat less robust finding is that people are less cooperative as groups increase in size, but that this curve might quickly flatten beyond a group size of five group members (Nosenzo et al. 2015; Wu et al. 2020). One explanation for why dyads are more cooperative than groups is that dyads are perfectly able to enact from reciprocity by only cooperating if the other does so as well (Axelrod 1984). Is it possible that larger groups can benefit from such reciprocity as well? As described in detail above (Reputation), the answer is yes: If one's choices in group cooperation decisions are observable while having dyadic (pairwise) interactions, group cooperation can be maintained by conditioning pairwise cooperation on your partner's group cooperation (Hauser et al. 2016; Milinski et al. 2002; Rand et al. 2009). If I will only cooperate in our dyadic interaction if you also cooperate in the group interaction, then you have an incentive to contribute to the group. Thus, making group behavior observable is essential for the global world to benefit from the cooperation-promoting power of local interactions.

Another line of research has focused on exposure to other groups, cultures, and nations, which can yield interconnectedness at the global level, referred to as globalization. Research was conducted in six distinct nations (USA, Italy, Russia, Argentina, South Africa, and Iran). Both across and within these nations, levels of globalization predicted higher contributions to global accounts that benefit others from around the world (Buchan et al. 2009). Access and interactions beyond your own group may cause individuals to draw broader group boundaries, and thus enhance global cooperation. In a sense, the world becomes psychologically closer to the self if one has been exposed to different parts of the world.

Distance from the ingroup. The ingroup is relatively close to the self, but relatively distal from the larger collective that bears the consequences of unsustainable behavior. For example, the ingroup can be your household, community, organization, or even country. As discussed in detail above (Regard for Others), people often favor groups and collectives closer to self than the entire world. For example, recent research on a new game, the Greater Good Game, distinguishes three choices: a selfish choice, a cooperative choice favoring the ingroup, and a pro-environmental choice (Klein et al. 2017). This new game uncovered that, just as a concern with self-interest, a concern with ingroup welfare too can pose an important threat to pro-environmental choices – again a reminder that parochial cooperation can be a strong threat to “global cooperation.”

Psychological solutions. A first approach to enhancing proximity is to highlight *harm to nature*. Clearly, many actions that are climate-unfriendly also have harmful effects in the here and now. There is good deal of research showing that empathy and the no-harm principle are easily activated in people, even when people consider the “other” as a meaningful entity or part of the world, including dogs, insects, and even trees (e.g., Bastian et al. 2021; Van Lange 2021). Indeed, people may attach significance to nature and the environment itself, often referred to as *biospheric values* (Steg et al. 2014; see also Stern & Dietz 1994). Sidebar 2 provides an overview of biospheric values. Highlighting concrete forms of harm to nature, even to insects such as crickets, can help people make more sustainable choices (Bastian et al. 2019). Highlighting nature can promote actions to protect the environment, such as not buying wood that involves depletion of natural forests or alternative actions that discourage industry and government from doing so.

A second approach to increasing proximity to the future is to consider those for whom the future matters more. The idea here is to emphasize that the young and vulnerable are the ones who will have to deal with the futures we create. These tendencies should be especially

strong if it concerns the young and vulnerable that share our genes: our (grand)children. Kinship likely played a key role in people evolving to cooperation in the first place (e.g., Hamilton 1964), and therefore kinship cues should be relatively effective in bringing the effects of climate change closer to the self (e.g., Krupp et al. 2008). Although more research is needed, including children in public education campaigns for increasing awareness of climate change seems like a promising approach to investigate. In doing so, intergenerational unfairness can be highlighted – the truism that irreversible harm is imposed by the present generation on future generations (who have not harmed us in any way, see Hauser et al. 2014 and Van Lange et al. 2018).

A third approach is to increase proximity to members of other groups beyond your favorite ingroups. Globalism can be reinforced in several ways, for example by watching movies or television programs from a different country, or connecting with people living in other parts of the country or world (Buchan et al. 2009). For example, young children may be encouraged at schools or at home to watch documentaries about other cultures, or to simply discuss climate change from an international perspective (e.g., Van der Linden et al. 2015). People may be informed about effective sustainability programs in other countries, with attention for positive results that have been obtained to increase a feeling of efficacy (or perhaps hope).

But ingroup (or local) cooperation can sometimes also foster global cooperation. We have highlighted the idea of pairwise (or local) cooperation, which if that succeeds, may lead to global cooperation (Hauser et al. 2016). Rather than bringing the world closer to the self, one could “use” the ingroup to promote local cooperation, which in turn may yield enhanced global cooperation. Indeed, local groups are often best equipped to manage local problems (Ostrom et al. 1992). And people are most likely to adhere to local sustainability norms when the local benefits of sustainable behavior are highlighted, such as decreasing the risk of

flooding in some countries and the risk of drought in other countries. Promotion of local actions can sometimes also be reinforced when intergroup comparison is enhanced - by ranking countries or cities according to shared criterion of sustainability - or when local leaders and advocates engage in the actions themselves, "practicing what they preach" (Kraft-Todd et al. 2018).

The Covid-19 Crisis

The Covid-19 pandemic is a massive societal challenge of unprecedented scale, directly infecting 10s of millions of people around the world, and substantially impacting the life of all of humankind. The fact that Covid-19 is infectious lays the groundwork for it being a social dilemma: Your actions do not affect you alone, but also influence the health outcomes of others. Therefore, behaviors that reduce the spread of Covid-19 - such as wearing masks, maintaining physical distance from others, avoiding travel, and getting vaccinated (Zhang et al. 2020) - contribute to the public good (Van Bavel et al. 2020). Of course, there are also benefits to individuals who avoid infection. However, what makes the Covid-19 crisis a particularly acute social dilemma is that there are substantial differences in risk between individuals. For example, the elderly are at much higher risk of death than the young, black and hispanic people are at higher risk of death than white people, and men are at higher risk of death than women (Carethers 2021). Thus, for many people, the individual benefit of avoiding infection is smaller than the individual costs associated with prevention behaviors. This creates the social dilemma: Do people who are at low risk incur the cost of Covid-19 prevention behaviors to reduce or avoid the collective risk of transmitting the disease to others who are more vulnerable?

COVID-19 is a social dilemma. The key question is whether COVID-19 prevention behaviors are related to forms of cooperative behavior as studied in the social dilemma literature. There is indeed some research that has addressed this since the outbreak, and the

answer is a preliminary yes. For example, research has found significantly higher intentions to engage in Covid-19 prevention behaviors among people who shared more money with another participant in a dictator game played years prior to the pandemic (Jordan et al. 2020). Similarly, prosociality in a neutrally-framed economic game where participants could put others at risk for their own benefit was positively correlated with Covid-19 prevention intentions, as well as with actually purchasing a mask, clicking to get more information about Covid-19, and donating to Covid-19 prevention charities (Campos-Mercade et al. 2020). Moreover, the extent to which individuals thought Covid-19 posed a threat to society was a stronger predictor of their prevention intentions than the perceived threat to themselves (Jordan et al. 2020), a finding that is consistent with the literature on social preferences that we discussed earlier.

In addition to these correlational analyses, a number of studies have investigated the effect of Covid-19 messaging that focuses on prevention behaviors' individual (self-interested messaging) versus collective (prosocial messaging) benefits. Some experiments find that prosocial messaging is more effective for increasing prevention intentions (e.g. Jordan et al. 2020; Luttrell & Petty 2020), while other experiments find no significant differences (e.g. Favero & Pedersen 2020). But we are not aware of any studies that find self-interested messaging to be more effective than prosocial messaging. Similarly, another experiment found that messaging that generates empathy for the vulnerable were effective in increasing prevention intentions (Pfafftheicher et al. 2020). Together, these results emphasize the social dilemma nature of Covid-19 prevention.

COVID-19 is a complex social dilemma. The Covid-19 crisis is not the same for everyone involved. For older and vulnerable people, the situation entails more risk, even life-threatening risks, than for younger and less vulnerable people (e.g., Carethers 2021). This means that for younger people, the health benefits of costly-prevention behaviors for

themselves are smaller than for older people, which implies that for younger and less vulnerable (versus older and more vulnerable) people prevention behaviors need to be motivated more strongly by prosocial concerns. Thus, depending on the level of risk for one's own health, people will face different social dilemmas. But above and beyond these differences, there are some other features that make Covid-19 more complex: (a) uncertainty and lack of information, and (b) the presence of multiple collectives, creating a multi-level social dilemma. We discuss both features in turn.

Uncertainty and Lack of Information. One challenging feature of Covid-19 derives from *uncertainty* and *lack of information*. In the social dilemma literature, some of the effects of uncertainty and lack of information are captured by research on *noise*, which refers to causing unintended consequences for others (Nowak & Sigmund 1993; Van Lange et al. 2002). Noise comes in two forms: Positive noise is when outcomes for others are better than intended, whereas negative noise is when outcomes for others are worse than intended (Van Lange et al. 2002). In the Covid-19 crisis, we certainly have cases of negative noise: Without knowing that you have the virus yourself, you may infect somebody else. Also, sometimes people may unintentionally violate agreed-upon physical distancing norms.

Research on social dilemmas has uncovered that noise tends to undermine trust in others' cooperativeness. For example, in noisy situations, people are less likely to attribute benign intentions to one another, and less likely to trust in others' cooperation - often resulting in lower cooperation (Klapwijk & Van Lange 2009). Part of the reason is that negative consequences are often more impactful than positive consequences, and therefore even an equal frequency of negative and positive noise is likely to undermine trust in others. Research has shown that one of the most powerful predictors of one's own cooperation is observations or beliefs regarding others' cooperation (for a meta-analysis, see Balliet & Van Lange 2013). People have a strong tendency to conform, to do what people see most other people doing

(e.g., Irwin & Simpson 2013). Covid-19 brings about considerable uncertainty for individuals *and* collectives. A clear example of individual-level uncertainty is about the effectiveness of wearing face masks for protecting oneself and others (Pennycook et al. 2020b). Another source of uncertainty follows from lack of clarity regarding the future -- how the virus will behave and mutate (e.g., Dawood 2020) and how effective vaccines will turn out to be (Halloran et al. 2010). As a rule of thumb, uncertainty tends to undermine cooperation, in part because it undermines feelings of responsibility and perceived efficacy in effectively contributing to collective welfare (Kerr 1992).

On the more “positive” side, the consequences of Covid-19 are immediate or short-term, which psychologically translates into fear, or a strong sense of urgency. Clearly, fear and a sense of urgency promote prevention behaviors that help protect oneself and close others. With more clarity and increasing information, such social dilemmas can often be managed well by effective leadership that focuses on informing people as accurately as possible (transparency) as well as providing absolute clarity in advice for concrete behavior (e.g., Podsakoff et al. 1990; Van Bavel et al. 2020). Needless to say, misinformation (fake news, to be discussed later; e.g., Pennycook et al. 2020c) adds to the level of uncertainty and noise that is already characteristic of Covid-19 as a social dilemma. And another complexity to misinformation is that people often selectively attend to information that is consistent with their beliefs or motives (Nickerson 1998; see also Fiske & Taylor 2013) with which they approached Covid-19.

Multi-level social dilemma. In many social dilemmas, there is an individual and a clearly defined collective. But for Covid-19, there are multiple collectives, which create a *multi-level social dilemma* (sometimes also called *layered* social dilemma, Wit & Kerr 2002). In the Covid-19 crisis, there are at least four distinct collectives. There is (a) the family level, the group of genetically-related others, or the level of household involving unrelated people (e.g.,

students); (b) the community level, the networks of friends, colleagues, and members of community with whom we regularly interact; (c) the national level, the category of people who often share government and institutes, similar norms and culture, and often are exposed to similar media influences; and (d) the international level, the people in the world who are connected to each other, even interdependent, but oftentimes do not directly interact or experience interdependence.

Does a crisis bring about an orientation toward self-interest? This may be true if the crisis brings about a strong conflict of interests between individual people, such that there is little benefit from mutual support. Indeed, as interests are more strongly conflicting, the level of cooperation will be smaller (for a meta-analysis, see Balliet & Van Lange 2013). However, in multi-level social dilemmas, things are different. In many multi-level dilemmas, people are involved in smaller units (e.g., family, household) that often benefit strongly from mutual cooperation, and may therefore provide strong norms for cooperation and develop patterns of sustainable cooperation. For example, one-on-one interactions elicit stable cooperation through powerful mechanisms such as reciprocity, which may help explain why most interactions in everyday life are between two people rather than large groups (e.g., Peperkoorn et al. 2020).

The family matters because it is the strongest unit that can help one another survive in times of crisis. The community matters because one may be interdependent with them in several ways through social exchange (e.g., getting groceries for the more vulnerable) and interaction (to keep physical distance). Sometimes, these forms of parochial cooperation may generalize to the national (or state) level, because that is the level of governmental policy and measures to coordinate and reduce the detrimental effects of Covid-19. Moreover, national identity is a strong determinant of identification and ingroup love (e.g., David & Bar-Tal 2009). Taken together, such tendencies toward ingroup-love are consistent with the growing

literature on parochial cooperation (see earlier section) showing that “ingroup-love” is strong, and often underlies sustained cooperation within groups (e.g., Halevy et al. 2012).

Often, the lack of cooperation arises at the international level. In part, this is because nations are either perceived to be fairly independent of one another, or face some conflict of interest. One striking example is the competition involved in ensuring vaccines for the people in one’s own country. Groups in particular are not good at dealing with scarce resources. One intriguing finding is that being a group’s representative makes causes a strong orientation towards the group’s interest, often so much so that the level of cooperation with other groups approximates zero and instead competition or rivalry may arise (Reinders Folmer et al. 2012). Moreover, people within a group often provide strong support to, and elect, representatives who are ingroup-serving at a cost to the larger collective (Milinski et al. 2016). And importantly, representatives are very poor at dealing with incidents of negative noise, whereby often a negative outcomes that may not be caused by another group are explained as intentional (Reinders Folmers et al. 2019). Groups fare less well than individuals in coping with noise.

Misinformation Crisis

Misinformation is nothing new. Yet concerns about false and misleading news have risen to a crisis level in recent years, fueled by a combination of factors including social media and the embrace of blatant falsehoods by certain political elites in many countries around the world (Lazer et al. 2018, Pennycook & Rand 2021a). For example, a certain strand of misinformation – often referred to as “fake news” – gained considerable attention in 2016 during the U.S. Presidential Election and U.K. Brexit vote, and continued to be a major source of concern during events such as the Covid-19 pandemic (Pennycook et al. 2020c) and the 2020 U.S. election (Pennycook & Rand 2021b). This form of misinformation, in which

individuals play an important role in transmitting falsehoods through their engagement and sharing behaviors, presents an important social dilemma: It is necessary for individuals to bear a variety of costs in order to create the collective benefit of an accurate information ecosystem.

Much of the considerable attention that has been paid to misinformation has focused on its potential for causing societal harm. For example, simply reading a blatantly false political claim increases subsequent belief via the “illusory truth” effect (Pennycook et al. 2018). This effect is so deeply rooted that it works equally well even for falsehoods that are unfavorable to your preferred party or that are tagged with warnings (Pennycook et al. 2018), and even for people who are more cognitively sophisticated (De keersmaecker et al. 2019). Exposure to blatantly false claims can also make the sharing of falsehoods seem less immoral (Effron & Raj 2019). There is debate about how prevalent “fake news” is on social media (Grinberg et al. 2019; Vosoughi et al. 2018) – with conclusions depending in part on how one defines misinformation (Rogers 2020) – and about the extent to which exposure changes underlying attitudes in addition to factual beliefs (Guess et al. 2020). Be that as it may, it is clear that many false claims are widely believed – e.g. many Americans inaccurately believing that there was widespread fraud in the 2020 Presidential Election (Pennycook & Rand 2021) – and that false beliefs can impact important decisions such as whether to get vaccinated (Loomba et al., 2021).

Misinformation as a social dilemma. The crisis of misinformation is a *cooperation* challenge because the societal ills generated by misinformation stand in tension with various individual benefits – such that addressing the misinformation crisis requires individuals to bear personal costs. There are several different social dilemmas embedded in the misinformation crisis. The *first* social dilemma involves individuals paying *effort* costs to assess information accuracy. Numerous studies have found that people who engage in more

critical thinking are less likely to fall for misinformation. For example, performance on the Cognitive Reflection Test (CRT) – a set of questions with intuitively compelling but incorrect answers that is widely used to measure extent of analytic thinking – is correlated with reduced belief in false news posts, and increased ability to discern between truth and falsehood (above and beyond factors such as education). This is true for blatantly false political posts, regardless of alignment with the reader’s partisanship (Pennycook & Rand 2019b, Bronstein et al. 2019); misleading – but not blatantly false – hyperpartisan political posts (Ross et al. 2019); and misinformation about Covid-19 (Pennycook et al. 2020c). Furthermore, cognitive load and time pressure selectively increase belief in false claims (Bago et al. 2020), as does instructing participants to rely on emotion while assessing the claims (Martel et al. 2020) – demonstrating a causal effect. This work suggests that exerting cognitive effort – which is often experienced as unpleasant and psychologically costly, and requires time and thus comes with opportunity costs – is an important part of reducing belief in misinformation.

Second, lack of effort also plays an important role in the sharing of, rather than belief in, misinformation. Numerous studies suggest that much of the sharing of false content results from failing to pay attention to accuracy, rather than purposeful sharing of falsehoods. People who scored higher on the CRT were more discerning in which news headlines they self-reported a willingness to share online (Pennycook et al. 2020c; Ross et al. 2019); and a hybrid lab-field study in which Twitter users completed the CRT found that performance was positively correlated the quality of news sources the users had actually shared (Mosleh et al. 2021b). Furthermore, using subtle primes to shift participants’ attention to the concept of accuracy when evaluating Facebook posts made their sharing intentions significantly more discerning, both for political news (Pennycook et al. 2021) and Covid-19 news (Pennycook et al. 2020c); as did asking participants to directly evaluate the accuracy of headlines before

sharing them (Pennycook et al. 2021). This approach has also been found to actually work in practice, as delivering a subtle accuracy prime intervention in a field experiment on Twitter increased the quality of news sources that users subsequently shared (Pennycook et al. 2021). Additional empirical and computational analyses suggest that most people do not want to share inaccurate content, but may wind up doing so when they simply fail to consider accuracy when deciding what to share (Pennycook et al. 2021). Thus, reducing the spread of misinformation also requires people to invest the effort needed to pay attention to accuracy, rather than only attending to more immediately accessible (and perhaps enjoyable) factors.

Finally, a different misinformation social dilemma, involving *temptation* (or benefits) rather than effort costs, arises for the relatively small fraction of people who knowingly share content that they believe to be false. These users reap personal benefits in exchange for perpetuating a societal harm. These benefits may include increased engagement with their posts, as some evidence suggests that false news may spread more than similar but true news (Vosoghi et al. 2018); advancing a political agenda, as most false content people share is aligned with their partisanship (Grinberg et al. 2019; Pennycook et al. 2021); attracting new followers/friends, e.g. because people are more likely to form social media connections with co-partisans (Mosleh et al. 2021 a); and satisfying a desire to sow chaos in the world (Petersen et al. 2018). Furthermore, implicit or explicit knowledge of these benefits may also make people less likely to attend to accuracy, amplifying the social dilemma of effort.

Solutions to misinformation raise new social dilemmas. Potential solutions to misinformation pose an enormous challenge. Moreover, some solutions may raise another social dilemma – sometimes called a *second-order social dilemma* – in which people must pay costs to reduce others’ free-riding (Yamagishi 1986; see also Balliet et al. 2011). Indeed, one promising top-down solution to the misinformation crisis poses such a dilemma: The use of warnings. If social media platforms were able to identify false or misleading posts, they

would be able to intervene effectively. Tagging misleading content with warnings can reduce belief (for a review, see Wittenberg & Berinsky 2020) and sharing (Pennycook et al. 2018; Pennycook et al. 2020a). But this approach is most effective when done quickly and when most false claims are identified. The warnings obviously do not help for the claims that are false but do not get tagged – and the absence of warnings may lead people to believe that these false posts had been checked and verified via the “implied truth effect” (Pennycook et al. 2020a). Even more powerfully, social media platforms can simply downrank content they believe to be inaccurate, such that fewer people see the content in the first place. Again, however, this is only effective to the extent that the platforms are able to catch misinformation at scale. Because of this scalability problem, professional fact-checkers are of limited use because their research process is slow and there are not very many fact-checking organizations. It would, however, be possible to identify misinformation at scale using the “wisdom of crowds”: Research found that a small number of laypeople, rating only a headline and lede sentence of articles flagged for fact-checking by Facebook’s internal algorithms, generated good agreement with professional fact-checkers reading and researching the full article (Allen et al. 2020); and crowds show even higher correlation with fact-checkers when rating the trustworthiness of news outlets (rather than individual articles) (Pennycook & Rand 2019b; Epstein et al. 2020). Crowdsourcing, however, relies on individual users investing the time to rate content. Thus, absent compensation from the social media platforms, misinformation identification poses a second order social dilemma where it is necessary for users to donate their time to rate content and thereby generate a public good.

Finally, a great deal of the responsibility for the misinformation crisis lies at the feet of media corporations (social media and well as TV and radio broadcasters) and politicians. This generates a fourth social dilemma of collective action. Collectively, citizens have the power to put pressure on companies (e.g. via boycotts) and politicians (e.g. by voting). But doing so

is individually costly. Boycotts require consumers to forgo products they enjoy, or pay higher prices by switching to more ethical competitors. Engaging in political advocacy is time consuming. And voting against politicians who spread misinformation but may represent one's interests in other domains may be psychologically, socially, and economically costly. Yet if enough people engage in such collective actions, the results can be truly powerful.

To summarize, the misinformation crisis can be characterized by two social dilemmas characterizing the basic situation and by two second-order social dilemmas when “structural” solutions are being implemented. Across these four different social dilemmas, we see that cooperation is critical for helping to address the misinformation crisis. It is imperative that future work leverages all that is known about how to promote cooperative behaviors in order to mobilize people around the globe to improve the quality of our information ecosystem.

SUMMARY AND CONCLUSIONS

Human cooperation is one of the most basic phenomena in social life. It raises fundamental questions about human nature, how the competitive process of evolution could give rise to people who so often cooperate with strangers, and how groups interact with other groups. Having provided a review of the recent literature, we wish to share our belief that for a comprehensive understanding of human cooperation, scholars need to rely on a *productive* combination of experimental research conducted in the lab as well as in the field. The vast majority of research on cooperation has been conducted in (physical or online) lab settings, largely using economic games. This body of work yields fundamental insights into drivers of cooperation. However, these insights are only societally useful (and theoretically interesting) in as much as they generalize to actual social dilemmas outside the lab. Thus, it is essential for both theory and application that results from the lab are tested in the field. While a growing body of work is undertaking such field experiments (for a review, see Kraft-Todd et

al. 2015), this work is largely being conducted outside of psychology. Thus, we call upon more psychologists to engage with field experiments and demonstrate the utility of the theories they have developed in the lab.

This is particularly critical for addressing the crises of climate change, COVID-19, and misinformation that we have highlighted in this review. In line with this review, we suggest that key mechanisms such as, for example, kinship, reciprocity, and reputation are important to not only understanding climate change, Covid-19, and misinformation, but also to finding solutions that might mitigate these three crises. Because distance from the self is a key challenge in climate change, kinship concerns may be leveraged by persuasion campaigns that highlight the detrimental effects for one's children, a concern that might bring the collective interest psychologically closer to the self for parents and grandparents. Because Covid-19 represents a multi-level social dilemma, reputational concerns may be highlighted in the smaller-scale collectives – for example, rapid tests at schools or organizations may not only help detect infected people but also help be more thoughtful before deciding to attend to school with a small signs of being infected. And because detecting misinformation requires attending to accuracy, interventions that emphasize the social obligation to avoid inaccuracies (and the potential reputational consequences of failing to do so) may be fruitful.

Closing remarks. The past decades of research on social dilemmas have shed important light on mechanisms through which individuals and groups promote and maintain cooperation. The field has grown in terms of theoretical knowledge, with a major push towards the development of overarching theories where new work contributes to extant theory rather than reinventing the wheel. The evolutionary theories of cooperation that integrate psychological processes with ultimate mechanisms are a strong case in point, as are psychological theories of reputation and social preferences. As our knowledge of human cooperation increases, so will research increasingly focus on connecting the dots – for

example, to examine the links between various beliefs, emotions, and neuroscientific processes, as well as interpersonal relationships, social networks, and group dynamics, when seeking to understand how to promote cooperation. The three crises addressed in this article – climate change, COVID-19, and misinformation – illustrate that one of the most important challenges for the (near) future is to connect insights from comparatively simple experimental settings to the complex social dilemmas of everyday life, in an attempt to understand and help design interventions and solutions to the various critical social dilemmas facing contemporary society. We believe that the field of human cooperation is in an ideal position to do so!

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Terms and Definitions

Direct reciprocity

Reciprocity in social dilemmas involves responding cooperatively to another's cooperative choice and responding noncooperatively to another's noncooperative choice. Direct reciprocity specifically refers reciprocity within the context of repeated interactions between the same individuals.

Reputation

Reputation is the impression (or "image score") that people have about a given person.

Person A's reputation in the eyes of Person B is often influenced by information provided by third parties (Person C, Person D, etc.) who have had direct interactions with, or observed interactions involving, Person A.

Positive regard for others

A preference to not harm others, and to instead adopt a readiness to engage in behavior that benefits others, often at a small or large cost to oneself.

Social mindfulness

This is an example of low-cost cooperation for which it is essential that one sees the option that favors another's wishes and needs. The construct is operationalized as making other-regarding choices involving both skill and will to act mindfully by leaving (rather than limiting) choice for another person.

Parochialism

A preference to increase the outcomes of members of an ingroup with which one is interdependent. This orientation can bring along costs to other groups or to a collective that comprises all groups.

Egalitarianism

A preference to reduce absolute differences in outcomes for self and others, often expressed by a strong aversion to inequality in outcomes.

Climate change crisis

A textbook example of a large-scale social dilemma in which behaviors serving short-term self-interest are conflicting with longer-term collective interests. This characterization already points at why the climate change crisis is so challenging – distance in time, distance from the self, and distance from ingroups.

COVID-19 crisis

The COVID-19 crisis is an ongoing global pandemic of *coronavirus disease 2019* (COVID-19) caused by *severe acute respiratory syndrome coronavirus 2* (SARS-CoV-2). It calls for somewhat costly individual behaviors such as wearing facemasks in public (buildings) and ensuring physical distance that help reduce collective health risks due the spreading of the virus.

Misinformation crisis

A crisis that is caused by the creating and sharing of information that is false, inaccurate, or otherwise misleading. There is often some individual cost (e.g. effort) associated with

assessing accuracy (and thus with avoiding the sharing of misinformation), and sometimes there are individual benefits associated with sharing misinformation. But the proliferation of misinformation has detrimental consequences to the collective, as it pollutes the information ecosystem and leads to inaccurate beliefs.

Fake News

News content published on the internet that aesthetically resembles actual legitimate mainstream news content, but that is fabricated or extremely inaccurate. Also referred to as false, junk, or fabricated news.

Second-order social dilemma

In a second order social dilemma, people do not face the decision whether to cooperate or not, but instead whether to make a contribution to encourage other people to make a cooperative choice or solve social dilemmas in other ways. Punishing free-riders, rewarding cooperators, or contributing to a system that administers these sanctions are examples of choices in a second order social dilemma.

Sidebar 1: Social Dilemmas

We define social dilemmas as situations in which a non-cooperative course of action is (at times) tempting for each individual in that it yields superior (often short-term) outcomes for self – but if all pursue this non-cooperative course of action, all are (often in the longer-term) worse off than if all had cooperated (Van Lange et al., 2013). This definition is inclusive of the well-known prisoner’s dilemma, as well as some other social dilemmas (i.e., Chicken Dilemma and the Assurance (or Trust) Dilemma). And importantly, this definition emphasizes the temporal features that are often associated with social dilemmas in everyday life, such that consequences for self are often immediate or short-term, while the consequences for the collective often unfold over longer periods of time. This temporal feature is perhaps most pronounced for the characterization of climate change as a social dilemma, in that present actions (e.g., flying, eating meat) often result in much delayed effects, such as the increase in temperature and the increased probability of ecological risk (e.g., flooding, droughts, heatwaves).

Sidebar 2: Biospheric values

Scientists have outlined the importance of biospheric values, which is defined as a value orientation in which “people judge phenomena on the basis of costs or benefits to ecosystems or the biosphere” (Stern & Dietz 1994). Considerable research supports this perspective, revealing that biospheric values make a relatively unique contribution in predicting sustainable behavior (see Steg et al. 2014). The key question is how one can make these abstract values more concrete? One way is to highlight the suffering of animals. A recent study focused on crickets, and their lives, in the context of so-called resource dilemma, an economic game that models climate change as a social dilemma (Bastian et al. 2019). When players believed that exhausting a resource would lead to the immediate death of live crickets they reduced personal consumption, equating to increased cooperation and greater collective benefit, relative to players given standard instructions. These findings highlight an important way in which sustainable behavior can be promoted: to emphasize the non-monetary – and especially the non-tradable – value of a resource. More generally, one challenge for climate change is to reduce abstractness in terms of time (e.g., highlighting harmful effects for children and grandchildren) or harm done to animal live (e.g., through deforestation).

Table 1: An overview of five evolutionary mechanisms

*Based on similarity between interaction partners***Kin selection**

The evolution of cooperation among genetically related individuals.

Spatial selection

The development of cooperation within networks of individuals due to clustering of individuals with similar strategies.

Group selection (or multi-level selection)

The development of cooperation within particular groups that are sufficiently impermeable (such as defectors are unlikely to arise in or enter).

*Based on repeated interaction***Direct reciprocity**

Reciprocity in social dilemmas involves responding cooperatively to another's cooperative choice and responding noncooperatively to another's noncooperative choice. It is called direct reciprocity as it concerns direct responses to another's behavior.

Reputation

Reputation is the impression (or image score) that people have from a second person, which is often influenced by information provided by a third person who has had direct interactions with that second person or who has observed interactions involving that second person.