

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

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Abstract

Contemporary society is facing many social dilemmas—including climate change, COVID-19, and misinformation—characterized by a conflict between short-term self-interest and longer-term collective interest. The climate crisis requires paying costs today to reduce climate-related harms and risks that we face 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 and abstain from spreading attractive falsehoods. Addressing these crises requires an understanding of human cooperation. To that end, we present (*a*) an overview of mechanisms for the evolution of cooperation, including mechanisms based on similarity and interaction; (*b*) a discussion of how reputation can incentivize cooperation via conditional cooperation and signaling; and (*c*) a review of social preferences that undergird the proximate psychology of cooperation, including positive regard for others, parochialism, and egalitarianism. We discuss the three focal crises facing our society through the lens of cooperation, emphasizing how cooperation research can inform our efforts to address them.

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INTRODUCTION

The world is faced with many cooperation challenges. At the time of this writing, in the winter of 2020–2021, the most immediate crisis is COVID-19. People are asked to comply with strict rules during a lockdown, often working from home and keeping physical distance from other people when outside (e.g., Van Bavel et al. 2020, Zhang et al. 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 and indicates the need for 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 or other for centuries but has recently been thrust into the public consciousness by the use of social media to propagate blatant lies by political elites (e.g., Lazer et al. 2018, Pennycook & Rand 2021b). Clearly, the three crises look very different, and indeed they are very different. They differ not only in their history and urgency but also in their concreteness and reversibility. Climate change seems abstract yet has largely irreversible consequences; 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 be dampened by immediate action.

To illuminate these crises, we review empirical research on human cooperation. This represents a broad topic in the scientific literature and is addressed by 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 of research activities and theories developed across various disciplines (e.g., Henrich & Muthukrishna 2021, Van Dijk & De Dreu 2021). Although our focus is largely psychological, we draw upon some key insights from evolutionary science, economics, and political science. In so doing, our review builds on two recent *Annual Review of Psychology* articles. Whereas Van Dijk & De Dreu (2021) provided 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 both within and beyond the context of economic games. And whereas Henrich & 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 on how they might illuminate specific societal crises that challenge our modern world.

Climate change crisis: a large-scale social dilemma in which behaviors serving short-term self-interest are conflicting with long(er)-term collective interests

Misinformation crisis: the spread of information that is false or highly misleading, often due to individuals failing to assess veracity before sharing

Fake news: content, often spread via the Internet, that aesthetically resembles legitimate news but is entirely fabricated or extremely inaccurate

We seek to accomplish two broad goals. The first is to provide a review of the basic science of human cooperation. Therefore, 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 we explore how 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.

Our 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 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 the long-standing promise of this interdisciplinary literature that key insights obtained from research on economic games, social dilemmas, and cooperative decision making may help address the 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, but research among social and behavioral scientists has largely focused on human cooperation (for a review, see Rand & Nowak 2013, Van Lange et al. 2013). The sidebar titled Social Dilemmas provides more information.

In particular, the prisoner's dilemma is especially apt to capture the social dilemma of cooperation. In this game, 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

Reputation: the impression that others have of a given person, which is often influenced by information provided by third parties

SOCIAL DILEMMAS

We define social dilemmas as situations in which a noncooperative course of action can be tempting for an individual in that it yields superior (often short-term) outcomes for the self and in which, if all were to pursue this noncooperative course of action, all would be (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 such as the 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 the self are often immediate or short-term, whereas the consequences for the collective often unfold over longer periods of time. This temporal feature is perhaps most pronounced in the social dilemma of climate change, in that present actions (e.g., flying or 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, heat waves).

Table 1 An overview of five evolutionary mechanisms

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 that defectors are unlikely to arise in or enter the group
Mechanisms based on repeated interaction	
Direct reciprocity	Responding cooperatively to another's cooperative choice and responding noncooperatively to another's noncooperative choice; called direct reciprocity as it concerns direct responses to another's behavior
Reputation	The impression (or image score) that an individual forms about another person, which is often influenced by information provided by a third person who has had direct interactions with that person or has observed interactions involving them

cooperating while one's partner defects, and the lowest payoff comes from defecting when one's 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 involved in the evolution of cooperation: 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, assortments 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 (or multilevel) 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 the similarity between interaction partners (also called assortment).

The remaining two mechanisms, direct reciprocity and reputation, are fundamentally different and operate instead via people's ability to condition their behavior toward others 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 bring individuals to cooperate only if their partners are also cooperative (e.g., tit-for-tat; Axelrod 1984).

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

Direct reciprocity: responding cooperatively to another's cooperation and noncooperatively to another's noncooperation, within the context of repeated interactions between the same individuals

cooperate with those in good reputation in order to maintain their own reputations (Ohtsuki & Iwasa 2006) and use cooperation to signal that they would be good partners (e.g., professional, romantic) (Gintis et al. 2001).

Reputation

Although each of the mechanisms mentioned above can allow for the evolution of cooperation, those involving reputation are particularly likely to be central to the cooperation among nonkin that forms the fabric of modern human societies (Rand & Nowak 2013). Reputation is a central feature of human social life and plays a key role in supporting human cooperation. The essence of reputation-based cooperation is that when others know about one individual's past actions—for example, through direct observation or gossip—how they act toward them may depend on how the individual acted previously. This can make it worthwhile for an individual to cooperate in two fundamentally different ways: conditional cooperation and signaling.

Conditional cooperation. In conditional cooperation (often referred to as reciprocity), one needs to cooperate today in order to receive the benefit of others cooperating with them in the future. Specifically, successful conditional strategies will result in cooperating only 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 any individual to incur costs to earn a good reputation—and therefore receive the benefits of others cooperating with them. 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 (a) require cooperation with a partner who is in good reputation and (b) allow noncooperation with a partner who is in bad reputation (Balliet et al. 2021, Ohtsuki & Iwasa 2006). Under such conditions, cooperation can be sustainable (i.e., it is a Nash equilibrium) and can be favored by evolution: The shadow of the future (Axelrod 1984) can make cooperation the advantageous choice today (provided that one's 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 defecting (Dal Bó & Fréchet 2011), although participants are also able to maintain cooperation in 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 four players simultaneously decide how much money to keep for themselves or contribute 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: An individual cooperates with either 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 only 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 in which 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 (2016) found stable cooperation in a repeated 1,000-person PGG in which each subject also played a repeated dyadic prisoner's dilemma with another group member. The power of observability to promote public goods has also been demonstrated outside of the lab. For example, Yoeli and colleagues (2013) tripled participation in a blackout prevention program (whereby the utility company would turn down air conditioning intensity on hot days) by having residents enroll using publicly posted sign-up sheets.

Furthermore, reciprocity can stabilize cooperation in situations in which 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 between rounds of cooperation games (Pfeiffer et al. 2012) and in experiments in which participants knew that others could share reputational information with other participants with whom they would become interdependent later on (e.g., Wu et al. 2016b).

More generally, people respond very strongly to the 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. 2016a), 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 one's name on a form can effectively promote donations (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, one cooperates as a way to attract new partners—that is, one's cooperation acts as a signal that others will benefit from interacting with that individual in the future. The cost the individual pays to cooperate is then offset by the benefit they 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 lower 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 higher 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 cooperation 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 & Rand 2020, Jordan et al. 2016a).

A second form of signaling involves credibly signaling that one will cooperate in the future. Here, cooperation is not the signal itself, but rather the outcome that 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 & Rand 2012, Manapat et al. 2013) and more interaction partners (Barclay & Willer 2007, Rand et al. 2011, Shirado 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 they cooperate more with emotional deciders (Levine et al. 2018). Moreover, 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

Whereas reputation effects can make it in one's self-interest 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, so that they will cooperate even when it is not self-interested to do so? As demonstrated by work using the notions of social preferences (e.g., Fischbacher & Gächter 2010), social value orientation (e.g., Van Lange 1999), and 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 resembles the paradigm described above, except that only 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, according to 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 Doosum et al. 2013). Whereas social dilemmas and the dictator game focus on material outcomes, social mindfulness captures the notion of leaving choice (or options) to 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 yogurt 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 yogurt and pick something else—even if cherry is the preferred option. The social mindfulness construct has been operationalized as “making other-regarding choices

Positive regard for others: a preference to engage in behavior that benefits others or minimizes harm to others, often at a small or large cost to oneself

Parochialism: a preference to increase the outcomes of ingroup members at a cost to oneself and/or members of other groups

Egalitarianism: a preference to reduce absolute differences in outcomes for self and others, often expressed as a strong aversion to inequality in outcomes

Social mindfulness: low-cost cooperation whereby one acts mindfully by leaving (rather than limiting) choice for another person

involving both skill and will to act mindfully by leaving (rather than limiting) choice for another person” (Van Doesum et al. 2013, p. 87).

In some studies, the average level of social mindfulness with strangers was about 65–70% among adults (Van Doesum et al. 2013, 2019a). Further, in typical social mindfulness choices, if people believe that there is no second chooser, the percentage of people choosing the nonunique item is 52%, whereas a large majority (78%) choose the nonunique item when that choice affects the option for a second person that is present—a clear demonstration that it is social mindfulness rather than a simple preference for a nonunique (or unique) object that guides this decision (Van Doesum et al. 2019b). 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 compared to robots (Nijssen et al. 2021), and with people from lower (versus higher) social classes (Van Doesum et al. 2017). 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 (Van Doesum et al. 2021).

Although we have discussed laboratory or related studies above, there is also a good deal of evidence showing that people are other-regarding toward strangers in other contexts as well (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—in 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. 2021). 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 the self. For example, many people recycle and 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—e.g., points or money—to their own group than to the outgroup, even when the basis for ingroup versus outgroup categorizations is trivial, such as preferences for famous 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 it has been contrasted with universal cooperation, or the positive regard for the entire collective, including the ingroup and outgroups (e.g., Aaldering & Böhm 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 the positive regard for the outcomes of the ingroup is stronger than the negative regard for the outgroup (e.g., Halevy et al. 2012, Weisel & Böhm 2015). Subsequent research has replicated this finding and provided some evidence for the notion that parochial cooperation is often stronger than universal cooperation. This finding 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 are based on shared social identities or ingroup-based trust (e.g., Tajfel & Turner 1979, Yamagishi et al. 1999).

Equally important, the motives underlying parochial cooperation are substantially different from those underlying universal cooperation, as shown by Aaldering & Böhm (2020, experiment 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 (i.e., positive concern with the ingroup coupled with hostile outlook at outgroups). In contrast, empathic concern is predictive of cooperation with the ingroup (weak parochialism) without hostility toward an outgroup. Moreover, a concern with equality (to be discussed next) seems a key predictor of universal cooperation (Aaldering & Böhm 2020). We conclude from this, and other research, that parochial cooperation 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. 1999). 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 have 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). Moreover, 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). Although it is well known that inequality that goes to one's advantage is less aversive than inequality that goes 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 non-Western societies the equal split is the most frequently chosen option (Engel 2011). Egalitarianism is a quite basic human tendency, and it has been shown to gradually develop in children between 3 and 8 years of age (e.g., Fehr et al. 2008). Egalitarianism may play an important role even in situations in which material outcomes do not directly matter. Research shows that many people value equality in receiving voice in decision-making procedures: If the supervisor asks some individual's opinion, they should be asking other's opinions as well (Van Prooijen et al. 2012).

Numerous behavioral 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 & Steinbeis 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, these findings show that 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, it 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 money as well) and is thus more feasible than traveling by train or bus. It is difficult to envision the ecological consequences of flying for the climate and thus to understand how detrimental flying 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 (Huckelba & Van Lange 2020, Van Lange et al. 2018): 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 in the present can have effects that will 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, individual differences in the consideration of future consequences 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 in the short term (e.g., Jacquet et al. 2013; see also Trope & Liberman 2010). In contrast to COVID-19, which poses risks for the collective and the self in the very near future (or even in the here and now), climate change lacks such urgency. 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."

However, that is not the whole story about 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 climate change (e.g., technological innovation) or magnify it (e.g., future underestimation of effects). 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 in the present can 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 is sometimes 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 doubts regarding one's own efficacy, or one group's efficacy, can seriously undermine one's 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 affecting 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 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 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 more. A somewhat less robust finding is that people are less cooperative as groups increase in size, but this curve seems to quickly flatten beyond a group size of five members (Nosenzo et al. 2015, Wu et al. 2020). One explanation for dyads' higher cooperation compared to groups is that dyads are perfectly able to enact—and benefit 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 (see the section titled 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 one's partner's group cooperation (Hauser et al. 2016, Milinski et al. 2002, Rand et al. 2009). If an agent will only cooperate in a dyadic interaction if their partner also cooperates in the group interaction, then their partner has 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 brought about by globalization, which can yield interconnectedness at the global level. Research was conducted in six nations (the United States, Italy, Russia, Argentina, South Africa, and Iran). Both across and within these nations, the levels of globalization predicted higher contributions to global accounts that benefit others from around the world (Buchan et al. 2009). Access to and interactions with groups beyond one's own may cause individuals to draw broader group boundaries, and thus they may enhance global cooperation. In a sense, the world becomes psychologically closer to the self if one has been exposed to different parts of it.

Distance from the ingroup. The ingroup is relatively close to the self but relatively distant from the larger collective that bears the consequences of unsustainable behavior. For example, the ingroup can be one's household, community, organization, or even country. As discussed in detail above (see the section titled Regard for Others), people often favor groups and collectives closer to the self than the rest of the 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 can, 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 a good deal of research showing that empathy and the no-harm principle are easily activated in people, even when people consider the other as meaningful entities or parts of the world such as dogs, insects, and even trees (e.g., Van Lange 2021; B. Bastian, C. Crimston, C. Klebl & P.A.M. Van Lange, unpublished manuscript). Indeed, people may attach significance to nature and the environment itself, based on what are often referred to as biospheric values (Steg et al. 2014; see also Stern & Dietz 1994). The sidebar titled Biospheric Values provides an overview of this concept. Stressing concrete examples 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

BIOSPHERIC VALUES

Scientists have outlined the importance of biospheric values, which are the result of 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 can one make these abstract values more concrete? One way is to highlight the suffering of animals. A recent study focused on the lives of crickets in the context of a 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, which would result in increased cooperation and greater collective benefit, compared to players given standard instructions. These findings highlight an important way in which sustainable behavior can be promoted: by emphasize the nonmonetary—and especially the nontradable—value of a resource. More generally, one challenge for climate change is to reduce perceived abstractness in terms of time (e.g., by highlighting the harmful effects for one's children and grandchildren) or the harm done to live animals (e.g., by emphasizing the consequences of deforestation).

actions to protect the environment, such as not buying wood that causes depletion of natural forests or acting to discourage industries and governments from doing so (Huckelba & Van Lange 2020).

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 those who will have to deal with the futures we create. This reminder should be especially effective if it concerns the young and vulnerable that share our genes: our (grand)children. Kinship likely played a key role in the evolution of human 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 on this, including children in public education campaigns to increase awareness of climate change seems like a promising approach. In doing so, intergenerational unfairness can be highlighted—that is, the truism that the present generation is imposing irreversible harm on future generations who have not harmed us in any way (see Hauser et al. 2014, Van Lange et al. 2018).

A third approach is to increase proximity to members of other groups beyond one's 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 world (Buchan et al. 2009). For example, young children may be encouraged at school or at home to watch documentaries about other cultures or simply to 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, and highlighting their positive results may 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 successful, 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—e.g., 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 affecting tens 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 its being a social dilemma: One's actions affect not only the agent but also 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 the individuals who avoid the infection. However, what makes the COVID-19 crisis a particularly acute social dilemma is that there are substantial differences in risk among individuals. For example, the risk of death is much higher for the elderly compared to the young, for Black and Hispanic people compared to Whites, and for men compared to 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: Will people who are at low risk incur the cost of COVID-19 prevention behaviors in order 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 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 had 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 in which 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 above.

In addition to these correlational analyses, a number of studies have investigated the effect of COVID-19 messaging that focuses on the individual (self-interested messaging) versus the collective (prosocial messaging) benefits of prevention behaviors. Some experiments find that prosocial messaging is more effective for increasing prevention intentions (e.g., Jordan et al. 2020, Luttrell & Petty 2021), whereas other experiments find no significant differences (e.g., Favero & Pedersen 2020). Another experiment finds that messaging that generates empathy for the vulnerable is effective in increasing prevention intentions (Pfattheicher et al. 2020). We are not aware of any studies that find self-interested messaging to be more effective than prosocial messaging. 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 risks, even life-threatening ones, than for younger and less vulnerable people (e.g., Carethers 2021). This means that for younger people, the personal health benefits of costly prevention behaviors are smaller than they

COVID-19 crisis:
a global pandemic that calls for individuals to wear face masks and maintain physical distance to benefit others by reducing viral spread

are for older people, which in turn implies that for younger and less 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. Above and beyond these differences, there are also other features that make COVID-19 an especially complex dilemma: (a) uncertainty and lack of information and (b) the presence of multiple collectives, which creates 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 the notion of noise, which refers to the causing of unintended consequences for others (Nowak & Sigmund 1993, Van Lange et al. 2002). Noise comes in two forms: positive noise, when outcomes for others are better than intended, and negative noise, 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: One may infect somebody else without even knowing that they have the virus themselves. 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, which often results 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 and to do what they see most other people doing (e.g., Irwin & Simpson 2013). COVID-19 brings about considerable uncertainty for both individuals and collectives. A clear example of individual-level uncertainty concerns the effectiveness of wearing face masks for protecting oneself and others (Pennycook et al. 2020b). Another source of uncertainty follows from a lack of clarity regarding the future—how the virus will behave and mutate (e.g., Dawood 2020) and how effective the 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 and a strong sense of urgency that promote prevention behaviors to protect oneself and others who are close. Such social dilemmas can often be managed well by an effective leadership that informs people with as much accuracy and transparency as possible and provides clear guidance on concrete behaviors to follow (e.g., Podsakoff et al. 1990, Van Bavel et al. 2020). Needless to say, misinformation (or fake news, discussed below; 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 compounded by misinformation is that people often selectively attend to information that is consistent with their prior beliefs or motives (Nickerson 1998; see also Fiske & Taylor 2013).

Multi-level social dilemma. In many social dilemmas, there is an individual and a clearly defined collective. In the case of COVID-19, however, there are multiple collectives, which create a multi-level social dilemma (sometimes also called layered social dilemma; Wit & Kerr 2002). There are at least four distinct collectives involved in the COVID-19 crisis: (a) the family level, or one's genetically related others and household members, even if unrelated; (b) the community level, or

the networks of friends, colleagues, and members of the community with whom one regularly interacts; (c) the national level, or people who share government and institutions, have similar norms and culture, and are often exposed to similar media influences; and (d) the international level, or people in the world who are connected to each other, even interdependent, but oftentimes do not interact directly 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 among individuals, such that there is little benefit from mutual support. Indeed, when interests are more strongly conflicting, the level of cooperation is lower (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 that 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 in large groups (e.g., Peperkoorn et al. 2020).

The family matters because it is the strongest unit that can help individuals survive in times of crisis. The community matters because one may be interdependent with it in several ways through social exchange (e.g., getting groceries for the more vulnerable) and interaction (e.g., keeping 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 that can 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 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 between countries to secure doses of the vaccine. Groups, in general, are not good at dealing with scarce resources. One intriguing finding is that being a group's representative causes a strong orientation toward the group's interest, often to the point that the level of cooperation with other groups approximates zero and competition or rivalry arises instead (Reinders Folmer et al. 2012). Moreover, people within a group often support and elect representatives who serve the ingroup at a cost to the larger collective (Milinski et al. 2016). And, importantly, representatives are very ineffective at dealing with incidents of negative noise, whereby a negative outcome associated with another group's action is perceived as intentional (e.g., another individual or group arrives late to an appointment due to a traffic jam that could not be foreseen) (Reinders Folmer et al. 2019). Groups fare worse 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 2021b). For example, a certain strand of misinformation, often referred to as fake news, gained considerable attention in 2016 during the US presidential election and the UK Brexit vote, and it continued to be a major source of concern during events such as the COVID-19 pandemic (Pennycook et al. 2020c) and the 2020 US presidential election (Pennycook & Rand 2021a). 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 so-called illusory truth effect (Pennycook et al. 2018). This effect is so deeply rooted that it works equally well for falsehoods that are unfavorable to one's preferred party or that are tagged with warnings (Pennycook et al. 2018) and even among 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 the 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 believe that there was widespread fraud in the 2020 presidential election (Pennycook & Rand 2021a)—and that false beliefs can affect important decisions, such as whether to get vaccinated or not (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, so 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 the 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 (Bronstein et al. 2019, Pennycook & Rand 2019b); 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), which demonstrates a causal effect. This work suggests that exerting cognitive effort—which is often experienced as unpleasant and psychologically costly, 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 a failure to pay attention to accuracy rather than a purposeful intention to share falsehoods. People who scored higher on the CRT were more discerning in selecting which news headlines they self-reported to be willing 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 CRT performance was positively correlated with 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 for both 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 work in practice, as delivering a subtle accuracy

prime intervention in a field experiment on Twitter increased the quality of news sources that the 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 end up doing so because 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 attending only 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 news that is true (Vosoughi 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, for example, because people are more likely to form social media connections with copartisans (Mosleh et al. 2021a); 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—whereby 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, 2020a). This approach, however, is most effective when done quickly and when most false claims are identified. The warnings obviously do not help with the claims that are false but do not get tagged, and the absence of warnings may lead people to believe that these false posts have been checked and verified via the implied truth effect (Pennycook et al. 2020a). Even more powerfully, social media platforms can simply down-rank 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 the headline and lead 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. 2021); and crowds show even higher correlation with fact-checkers when rating the trustworthiness of news outlets (rather than of individual articles) (Epstein et al. 2020, Pennycook & Rand 2019a). Crowdsourcing, however, relies on individual users investing their time to rate content. Thus, absent compensation from the social media platforms, misinformation identification poses a second order social dilemma in that 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 as 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

Second-order social dilemma: the choice of whether to make a contribution to encourage others to contribute, e.g., via reward or punishment

companies (e.g., via boycotts) and politicians (e.g., by voting). Doing so, however, is individually costly. Boycotts require consumers to forgo products they enjoy or to pay higher prices by switching to more ethical competitors. Engaging in political advocacy is time consuming. And voting against politicians who spread misinformation but who 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 arising 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 leverage 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, about 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 the drivers of cooperation. However, these insights are only societally useful (and theoretically interesting) inasmuch as they generalize to actual social dilemmas outside the lab. Thus, it is essential for both theory and application that results from the lab be tested in the field. Although 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 our argument so far, we suggest that key mechanisms such as, for example, kinship, reciprocity, and reputation are important not only to 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 detect infected people but also help them be more thoughtful before deciding to attend to school with possible signs of infection. 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.

The past decades of research on social dilemmas have shed important light on the mechanisms through which individuals and groups promote and maintain cooperation. The field has grown in terms of theoretical knowledge, with a major push toward the development of overarching theories that contribute to the existing knowledge 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, by examining 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 apply insights from comparatively simple experimental settings to the complex social dilemmas of everyday life, in an attempt to understand them and help design successful interventions. We believe that the field of human cooperation is in an ideal position to do so!

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LITERATURE CITED

- Aaldering H, Böhm R. 2020. Parochial versus universal cooperation: introducing a novel economic game of within- and between-group interaction. *Soc. Psychol. Pers. Sci.* 11:36–45
- Aaldering H, Ten Velden FS, van Kleef GA, De Dreu CKW. 2018. Parochial cooperation in nested intergroup dilemmas is reduced when it harms out-groups. *J. Pers. Soc. Psychol.* 114:909–23
- Allen J, Arechar AA, Pennycook G, Rand DG. 2021. Scaling up fact-checking using the wisdom of crowds. *Sci. Adv.* 7:eabf4393
- Axelrod RM. 1984. *The Evolution of Cooperation*. New York: Basic Books
- Bago B, Rand DG, Pennycook G. 2020. Fake news, fast and slow: Deliberation reduces belief in false (but not true) news headlines. *J. Exp. Psychol. Gen.* 149:1608–13
- Balliet D, Mulder LB, Van Lange PAM. 2011. Reward, punishment, and cooperation: a meta-analysis. *Psychol. Bull.* 137:594–615
- Balliet D, Van Lange PAM. 2013. Trust, conflict, and cooperation: a meta-analysis. *Psychol. Bull.* 139:1090–1112
- Balliet D, Wu J, Van Lange PAM. 2021. Indirect reciprocity, gossip, and reputation-based cooperation. In *Social Psychology: Handbook of Basic Principles*, Vol. 3. ed. PAM Van Lange, ET Higgins, AW Kruglanski, pp. 265–87. New York: Guilford
- Barclay P. 2006. Reputational benefits for altruistic punishment. *Evol. Hum. Behav.* 27:325–44
- Barclay P, Willer R. 2007. Partner choice creates competitive altruism in humans. *Proc. Biol. Sci.* 274:749–53
- Bastian B, Brewer MB, Duffy J, Van Lange PAM. 2019. From cash to crickets: The non-monetary value of a resource can promote human cooperation. *J. Environ. Psychol.* 61:10–19
- Bloom P. 2016. *Against Empathy: The Case for Rational Compassion*. New York: Ecco
- Böhm R, Theelen MMP, Rusch H, Van Lange PAM. 2018. Costs, needs, and integration efforts shape helping behavior toward refugees. *PNAS* 115:7284–89
- Bolton GE, Katok E, Ockenfels A. 2005. Cooperation among strangers with limited information about reputation. *J. Public Econ.* 89:1457–68
- Brewer MB. 1999. The psychology of prejudice: in-group love and out-group hate? *J. Soc. Issues* 55:429–44
- Bronstein MV, Pennycook G, Bear A, Rand DG, Cannon TD. 2019. Belief in fake news is associated with delusionality, dogmatism, religious fundamentalism, and reduced analytic thinking. *J. Appl. Res. Mem. Cogn.* 8:108–17
- Buchan N, Grimalda G, Wilson R, Brewer MB, Fatas E, Foddy M. 2009. Globalization and human cooperation. *PNAS* 106:4138–42
- Campos-Mercade P, Meier A, Schneider F, Wengström E. 2020. *Prosociality predicts health behaviors during the COVID-19 pandemic*. Work. Pap. 346, Dep. Econ., Univ. Zürich, Zürich
- Carethers JM. 2021. Insights into disparities observed with COVID-19. *J. Intern. Med.* 289:463–73

- Cohn A, Maréchal MA, Tannenbaum D, Zünd CL 2019. Civic honesty around the globe. *Science* 365(6448):70–73
- Dal Bó P, Fréchette GR. 2011. The evolution of cooperation in infinitely repeated games: experimental evidence. *Am. Econ. Rev.* 101:411–29
- David O, Bar-Tal D. 2009. A sociopsychological conception of collective identity: the case of national identity as an example. *Pers. Soc. Psychol. Rev.* 13:354–79
- Dawood AA. 2020. Mutated COVID-19 may foretell a great risk for mankind in the future. *New Microbes New Infect.* 35:100673
- De Keersmaecker J, Dunning D, Pennycook G, Rand DG, Sanchez C, et al. 2019. Investigating the robustness of the illusory truth effect across individual differences in cognitive ability, need for cognitive closure, and cognitive style. *Pers. Soc. Psychol. Bull.* 46:204–15
- Effron DA, Raj M. 2019. Misinformation and morality: Encountering fake-news headlines makes them seem less unethical to publish and share. *Psychol. Sci.* 31:75–87
- Ellemers N, De Gilder D. 2021. Categorization and identity as motivational principles in intergroup relations. In *Social Psychology: Handbook of Basic Principles*, Vol. 3, ed. PAM Van Lange, ET Higgins, AW Kruglanski, pp. 452–72. New York: Guilford.
- Engel C. 2011. Dictator games: a meta study. *Exp. Econ.* 14:583–610
- Epley N, Schroeder J. 2014. Mistakenly seeking solitude. *J. Exp. Psychol. Gen.* 143:1980–99
- Epstein Z, Pennycook G, Rand DG. 2020. Will the crowd game the algorithm? Using layperson judgments to combat misinformation on social media by downranking distrusted sources. In *CHI '20: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. New York: ACM. <https://doi.org/10.1145/3313831.3376232>
- Eriksson K, Strimling P, Gelfand MJ, Wu J, Abernathy J, et al. 2021. Perception of the appropriate response to norm violations in 57 societies. *Nat. Commun.* 12:1481
- Favero N, Pedersen MJ. 2020. How to encourage “Togetherness by Keeping Apart” amid COVID-19? The ineffectiveness of prosocial and empathy appeals. *J. Behav. Public Adm.* 3(2). <https://doi.org/10.30636/jbpa.32.167>
- Fehr E, Bernhard H, Rockenbach B. 2008. Egalitarianism in young children. *Nature* 454:1079–83
- Fehr E, Fischbacher U. 2004. Third-party punishment and social norms. *Evol. Hum. Behav.* 25:63–87
- Fehr E, Gächter S. 2000. Cooperation and punishment in public goods experiments. *Am. Econ. Rev.* 90:980–94
- Fehr E, Schmidt KM. 1999. A theory of fairness, competition, and cooperation. *Q. J. Econ.* 114:817–68
- Fischbacher U, Gächter S. 2010. Social preferences, beliefs, and the dynamics of free riding in public goods experiments. *Am. Econ. Rev.* 100:541–56
- Fiske ST, Taylor SE. 2013. *Social Cognition: From Brains to Culture*. London: SAGE. 2nd ed.
- Fudenberg D, Rand DG, Dreber A. 2012. Slow to anger and fast to forgive: cooperation in an uncertain world. *Am. Econ. Rev.* 102:720–49
- Gifford R. 2011. The dragons of inaction: psychological barriers that limit climate change mitigation and adaptation. *Am. Psychol.* 66:290–302
- Gilead M, Trope Y, Liberman N. 2020. Above and beyond the concrete: the diverse representational substrates of the predictive brain. *Behav. Brain Sci.* 43:e121
- Gintis H, Smith EA, Bowles S. 2001. Costly signaling and cooperation. *J. Theor. Biol.* 213:103–19
- Grinberg N, Joseph K, Friedland L, Swire-Thompson B, Lazer D. 2019. Fake news on Twitter during the 2016 US presidential election. *Science* 363(6425):374–78
- Guess AM, Lockett L, Benjamin L, Montgomery JM, Nyhan B, Reifler J. 2020. “Fake news” may have limited effects beyond increasing beliefs in false claims. *Harv. Kennedy Sch. Misinformation Rev.* 1(1). <https://doi.org/10.37016/mr-2020-004>
- Gunaydin G, Oztekin H, Karabulut DH, Salman-Engin S. 2021. Minimal social interactions with strangers predict greater subjective well-being. *J. Happiness Stud.* 22:1839–53
- Halevy N, Weisel O, Bornstein G. 2012. “In-group love” and “out-group hate” in repeated interaction between groups. *J. Behav. Decis. Mak.* 25:188–95
- Halloran ME, Longini IM Jr., Struchiner CJ. 2010. *Design and Analysis of Vaccine Studies*. New York: Springer
- Hamilton WD. 1964. The genetical evolution of social behaviour. II. *J. Theor. Biol.* 7:17–52

- Hardin G. 1968. The tragedy of the commons. *Science* 162:1243–48
- Hauser OP, Hendriks A, Rand DG, Nowak MA. 2016. Think global, act local: preserving the global commons. *Sci. Rep.* 6:36079
- Hauser OP, Rand DG, Peysakhovich A, Nowak MA. 2014. Cooperating with the future. *Nature* 511:220–23
- Henrich J, Muthukrishna M. 2021. The origins and psychology of human cooperation. *Annu. Rev. Psychol.* 72:207–40
- Ho AK, Sidanius J, Kteily N, Sheehy-Skeffington J, Pratto F, et al. 2015. The nature of social dominance orientation: theorizing and measuring preferences for intergroup inequality using the new SDO scale. *J. Pers. Soc. Psychol.* 109:1003–28
- Huckelba AL, Van Lange PAM. 2020. The silent killer: consequences of climate change and how to survive past the year 2050. *Sustainability* 12:3757
- Irwin K, Simpson B. 2013. Do descriptive norms solve social dilemmas? Conformity and contributions in collective action groups. *Soc. Forces* 91:1057–84
- Jacquet J, Hagel K, Hauert C, Marotzke J, Röhl T, Milinski M. 2013. Intra- and intergenerational discounting in the climate game. *Nat. Clim. Change* 3:1025–28
- Joireman JA, Van Lange PAM, Van Vugt M. 2004. Who cares about the environmental impact of cars? Those with an eye toward the future. *Environ. Behav.* 36:187–206
- Jordan JJ, Hoffman M, Bloom P, Rand DG. 2016a. Third-party punishment as a costly signal of trustworthiness. *Nature* 530(7591):473–76
- Jordan JJ, Hoffman M, Nowak MA, Rand DG. 2016b. Uncalculating cooperation is used to signal trustworthiness. *PNAS* 113(31):8658–63
- Jordan JJ, Rand DG. 2020. Signaling when no one is watching: a reputation heuristics account of outrage and punishment in one-shot anonymous interactions. *J. Pers. Soc. Psychol.* 118:57–88
- Jordan JJ, Yoeli E, Rand DG. 2020. Don't get it or don't spread it? Comparing self-interested versus prosocial motivations for COVID-19 prevention behaviors. PsyArXiv, April 3. <https://doi.org/10.31234/osf.io/yuq7x>
- Kerr NL 1992. Efficacy as a causal and moderating variable in social dilemmas. In *Social Dilemmas: Theoretical Issues and Research Findings*, ed. WBG Liebrand, DM Messick, HAM Wilke, pp. 59–80. Oxford, UK: Pergamon
- Klapwijk A, Van Lange PAM. 2009. Promoting cooperation and trust in “noisy” situations: the power of generosity. *J. Pers. Soc. Psychol.* 96:83–103
- Klein SA, Hilbig BE, Heck DW. 2017. Which is the greater good? A social dilemma paradigm disentangling environmentalism and cooperation. *J. Environ. Psychol.* 53:40–49
- Kraft-Todd GT, Bollinger B, Gillingham K, Lamp S, Rand D. 2018. Credibility-enhancing displays promote the provision of non-normative public goods. *Nature* 563(7730):245–48
- Kraft-Todd GT, Yoeli E, Bhanot S, Rand DG. 2015. Promoting cooperation in the field. *Curr. Opin. Behav. Sci.* 3:96–101
- Krupp DB, DeBruine LM, Barclay P. 2008. A cue of kinship promotes cooperation for the public good. *Evol. Hum. Behav.* 29:49–55
- Lazer DM, Baum MA, Benkler Y, Berinsky AJ, Greenhill KM, et al. 2018. The science of fake news. *Science* 359(6380):1094–96
- Levine EE, Barasch A, Rand D, Berman JZ, Small DA. 2018. Signaling emotion and reason in cooperation. *J. Exp. Psychol. Gen.* 147:702–19
- Loomba S, de Figueiredo A, Piatek SJ, de Graaf K, Larson HJ. 2021. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. *Nat. Hum. Behav.* 5:337–48
- Luttrell A, Petty RE. 2021. Evaluations of self-focused versus other-focused arguments for social distancing: an extension of moral matching effects. *Soc. Psychol. Pers. Sci.* 12:946–54
- Manapat ML, Nowak MA, Rand DG. 2013. Information, irrationality, and the evolution of trust. *J. Econ. Behav. Organ.* 90:57–75
- Manapat ML, Rand DG. 2012. Delayed and inconsistent information and the evolution of trust. *Dyn. Games Appl.* 2:401–10
- Martel C, Pennycook G, Rand DG. 2020. Reliance on emotion promotes belief in fake news. *Cogn. Res.* 5:47

- Mendes N, Steinbeis N, Bueno-Guerra N, Call J, Singer T. 2018. Preschool children and chimpanzees incur costs to watch punishment of antisocial others. *Nat. Hum. Behav.* 2:45–51
- Milinski M, Hilbe C, Semmann D, Sommerfeld R, Marotzke J. 2016. Humans choose representatives who enforce cooperation in social dilemmas through extortion. *Nature Commun.* 7:11915
- Milinski M, Semmann D, Krambeck HJ. 2002. Reputation helps solve the “tragedy of the commons.” *Nature* 415:424–26
- Mosleh M, Martel C, Eckles D, Rand DG. 2021a. Shared partisanship dramatically increases social tie: formation in a Twitter field experiment. *PNAS* 118(7):e2022761118
- Mosleh M, Pennycook G, Arechar AA, Rand DG. 2021b. Cognitive reflection correlates with behavior on Twitter. *Nat. Commun.* 12:921
- Nickerson RS. 1998. Confirmation bias: a ubiquitous phenomenon in many guises. *Rev. Gen. Psychol.* 2:175–220
- Nijssen SRR, Heyselaar E, Müller BCN, Bosse T. 2021. Do we take a robot’s needs into account? The effect of humanization on prosocial considerations toward other human beings and robots. *Cyberpsychol. Behav. Soc. Netw.* 24:332–36
- Nosenzo D, Quercia S, Sefton M. 2015. Cooperation in small groups: the effect of group size. *Exp. Econ.* 18:4–14
- Nowak MA. 2006. Five rules for the evolution of cooperation. *Science* 314:1560–63
- Nowak MA, Sigmund K. 1993. A strategy of win-stay, lose-shift that outperforms tit-for-tat in the Prisoner’s Dilemma game. *Nature* 364:56–58
- O’Connor J, Keil M. 2017. The effects of construal level and small wins framing on an individual’s commitment to an environmental initiative. *J. Environ. Psychol.* 52:1–10
- Ohtsuki H, Iwasa Y. 2006. The leading eight: social norms that can maintain cooperation by indirect reciprocity. *J. Theor. Biol.* 239:435–44
- Ostrom E, Walker J, Gardner R. 1992. Covenants with and without the sword: Self-governance is possible. *Am. Political Sci. Rev.* 86:404–17
- Pennycook G, Bear A, Collins E, Rand DG. 2020a. The implied truth effect: Attaching warnings to a subset of fake news headlines increases perceived accuracy of headlines without warnings. *Manag. Sci.* 66:4944–57
- Pennycook G, Cannon TD, Rand DG. 2018. Prior exposure increases perceived accuracy of fake news. *J. Exp. Psychol. Gen.* 147:1865–80
- Pennycook G, Epstein Z, Mosleh M, Arechar AA, Eckles D, Rand DG. 2021. Shifting attention to accuracy can reduce misinformation online. *Nature* 592:590–95
- Pennycook G, McPhetres J, Bago B, Rand DG. 2020b. Beliefs about COVID-19 in Canada, the U.K., and the U.S.A.: a novel test of political polarization and motivated reasoning. PsyArXiv, April 14. <https://doi.org/10.31234/osf.io/zhjpk>
- Pennycook G, McPhetres J, Zhang Y, Lu JG, Rand DG. 2020c. Fighting COVID-19 misinformation on social media: experimental evidence for a scalable accuracy-nudge intervention. *Psychol. Sci.* 31:770–80
- Pennycook G, Rand DG. 2019a. Fighting misinformation on social media using crowdsourced judgments of news source quality. *PNAS* 116(7):2521–26
- Pennycook G, Rand DG. 2019b. Lazy, not biased: Susceptibility to partisan fake news is better explained by lack of reasoning than by motivated reasoning. *Cognition* 188:39–50
- Pennycook G, Rand DG. 2021a. Research note: examining false beliefs about voter fraud in the wake of the 2020 presidential election. *Harv. Kennedy Sch. Misinformation Rev.* 2(1). <https://doi.org/10.37016/mr-2020-51>
- Pennycook G, Rand DG. 2021b. The psychology of fake news. *Trends Cogn. Sci.* 25(5):388–402
- Peperkoorn LS, Becker DV, Balliet D, Columbus S, Molho C, Van Lange PAM. 2020. The prevalence of dyads in social life. *PLOS ONE* 15:e0244188
- Petersen M, Osmundsen M, Arceneaux K. 2018. The “need for chaos” and motivations to share hostile political rumors. PsyArXiv, Sept. 1. <https://doi.org/10.31234/osf.io/6m4ts>
- Peysakhovich A, Nowak MA, Rand DG. 2014. Humans display a “cooperative phenotype” that is domain general and temporally stable. *Nat. Commun.* 5:4939
- Pfathheicher S, Nockur L, Böhm R, Sassenrath C, Petersen M. 2020. The emotional path to action: Empathy promotes physical distancing and wearing of face masks during the COVID-19 pandemic. PsyArXiv, Sept. 29. <https://doi.org/10.1177/0956797620964422>

- Pfeiffer T, Tran L, Krimme C, Rand DG. 2012. The value of reputation. *J. R. Soc. Interface* 9:2791–97
- Podsakoff PM, MacKenzie SB, Moorman RH, Fetter R. 1990. Transformational leader behaviors and their effects on followers' trust in leader, satisfaction, and organizational citizenship behaviors. *Leadersh. Q.* 1:107–42
- Rand DG, Arbesman S, Christakis NA. 2011. Dynamic social networks promote cooperation in experiments with humans. *PNAS* 108:19193–98
- Rand DG, Dreber A, Ellingsen T, Fudenberg D, Nowak MA. 2009. Positive interactions promote public cooperation. *Science* 325:1272–75
- Rand DG, Fudenberg D, Dreber A. 2015. It's the thought that counts: the role of intentions in noisy repeated games. *J. Econ. Behav. Organ.* 116:481–99
- Rand DG, Nowak MA. 2013. Human cooperation. *Trends Cogn. Sci.* 17:413–25
- Reinders Folmer CP, Klapwijk A, De Cremer D, Van Lange PAM. 2012. One for all: what representing a group may do to us. *J. Exp. Soc. Psychol.* 48:1047–56
- Reinders Folmer CP, Wildschut T, De Cremer D, Van Lange PAM. 2019. Coping with noise in social dilemmas: Group representatives fare worse than individuals because they lack trust in others' benign intentions. *Group Process. Intergroup Relat.* 22:200–14
- Rogers R. 2020. Research note: The scale of Facebook's problem depends upon how 'fake news' is classified. *Harv. Kennedy Sch. Misinformation Rev.* 1(6). <https://doi.org/10.37016/mr-2020-43>
- Ross RM, Rand D, Pennycook G. 2019. Beyond "fake news": the role of analytic thinking in the detection of inaccuracy and partisan bias in news headlines. *PsyArXiv*, Nov. 13. <http://doi.org/10.31234/osf.io/cgsx6>
- Shirado H, Fu F, Fowler JH, Christakis NA. 2013. Quality versus quantity of social ties in experimental cooperative networks. *Nat. Commun.* 4:2814
- Sidanius J, Pratto F. 2012. Social dominance theory. In *Handbook of Theories of Social Psychology*, Vol. 2, ed. PAM Van Lange, AW Kruglanski, ET Higgins, pp 418–38. Thousand Oaks, CA: SAGE
- Singer T, Steinbeis N. 2009. Differential roles of fairness- and compassion-based motivations for cooperation, defection, and punishment. *Ann. N. Y. Acad. Sci.* 1167:41–50
- Sommerfeld RD, Krambeck HJ, Semmann D, Milinski M. 2007. Gossip as an alternative for direct observation in games of reciprocity. *PNAS* 104:17425–40
- Steg L, Bolderdijk JW, Keizer K, Perlaviciute G. 2014. An integrated framework for encouraging pro-environmental behaviour: the role of values, situational factors and goals. *J. Environ. Psychol.* 38:104–15
- Stern PC, Dietz T. 1994. The value basis of environmental concern. *J. Soc. Issues* 50:65–84
- Tajfel H, Turner JC. 1979. An integrative theory of intergroup conflict. In *The Social Psychology of Intergroup Relations*, ed. WG Austin, S Worchel, pp. 33–47. Monterey, CA: Brooks-Cole
- Trope Y, Liberman N. 2010. Construal-level theory of psychological distance. *Psychol. Rev.* 117:440–63
- Van Bavel JJ, Baicker K, Boggio PS, et al. 2020. Using social and behavioural science to support COVID-19 pandemic response. *Nat. Hum. Behav.* 4:460–71
- Van der Linden S, Maibach E, Cook J, Leiserowitz A, Lewandowsky S. 2017. Inoculating against misinformation. *Science* 358(6367):1141–42
- Van der Linden S, Maibach E, Leiserowitz A. 2015. Improving public engagement with climate change: five "best practice" insights from psychological science. *Perspect. Psychol. Sci.* 10:758–63
- Van Dijk E, De Dreu CKW. 2021. Experimental games and social decision making. *Annu. Rev. Psychol.* 72:415–38
- Van Doesum NJ, De Vries RE, Blokland AAJ, Hill JM, Kuhlman DM, et al. 2019a. Social mindfulness: prosocial the active way. *J. Posit. Psychol.* 15:183–93
- Van Doesum NJ, Karremans J, Fikke R, De Lange M, Van Lange PAM 2019b. Social mindfulness in the real world: The physical presence of others induces other-regarding motivation. *Soc. Influence* 13:209–22
- Van Doesum NJ, Murphy R, Aharonov-Majar E, Athenstaedt U, Au WT, et al. 2021. Social mindfulness and prosociality across the globe. *PNAS* 118:e2023846118
- Van Doesum NJ, Tybur JB, Van Lange PAM. 2017. Class impressions: Higher social class elicits lower prosociality. *J. Exp. Soc. Psychol.* 68:11–20
- Van Doesum NJ, Van Lange DAW, Van Lange PAM. 2013. Social mindfulness: skill and will to navigate the social world. *J. Pers. Soc. Psychol.* 105:86–103

- Van Lange PAM. 1999. The pursuit of joint outcomes and equality in outcomes: an integrative model of social value orientation. *J. Pers. Soc. Psychol.* 77:337–49
- Van Lange PAM. 2021. A broader mind: concern with other humans, equality, and animals. *Curr. Opin. Behav. Sci.* 42:109–13
- Van Lange PAM, Columbus S. 2021. Vitamin S: Why is social contact, even with strangers, so important to well-being? *Curr. Dir. Psychol. Sci.* 30:267–73
- Van Lange PAM, Joireman JA, Milinski M. 2018. Climate change: what psychology can offer in terms of insights and solutions. *Curr. Dir. Psychol. Sci.* 27:269–74
- Van Lange PAM, Joireman JA, Parks CD, Van Dijk E. 2013. The psychology of social dilemmas: a review. *Organ. Behav. Hum. Decis. Process.* 120:125–41
- Van Lange PAM, Ouwerkerk JW, Tazelaar MJ. 2002. How to overcome the detrimental effects of noise in social interaction: the benefits of generosity. *J. Pers. Soc. Psychol.* 82:768–80
- Van Prooijen JW, Ståhl T, Eek D, Van Lange PAM. 2012. Injustice for all or just for me? Social value orientation predicts responses to own versus other's procedures. *Pers. Soc. Psychol. Bull.* 38:1247–58
- Van Veelen M. 2009. Group selection, kin selection, altruism and cooperation: when inclusive fitness is right and when it can be wrong. *J. Theor. Biol.* 259:589–600
- Vosoughi S, Roy D, Aral S. 2018. The spread of true and false news online. *Science* 359(6380):1146–51
- Weber EU 2006. Experience-based and description-based perceptions of long-term risk: why global warming does not scare us (yet). *Clim. Change* 77:103–20
- Wedekind C, Milinski M. 2000. Cooperation through image scoring in humans. *Science* 288:850–52
- Weisel O, Böhm R. 2015. “Ingroup love” and “outgroup hate” in intergroup conflict between natural groups. *J. Exp. Soc. Psychol.* 60:110–20
- Willer R. 2009. Groups reward individual sacrifice: the status solution to the collective action problem. *Am. Sociol. Rev.* 74:23–43
- Wit AP, Kerr NL. 2002. “Me versus just us versus us all” categorization and cooperation in nested social dilemmas. *J. Pers. Soc. Psychol.* 83:616–37
- Wittenberg C, Berinsky AJ. 2020. Misinformation and its correction. In *Social Media and Democracy: The State of the Field and Prospects for Reform*, ed. N. Persily, JA Tucker, pp. 163–197. Cambridge, UK: Cambridge Univ. Press
- Wu J, Balliet D, Peperkoorn LS, Romano A, Van Lange PAM. 2020. Cooperation in groups of different sizes: the effects of punishment and reputation-based partner choice. *Front. Psychol.* 10:2956
- Wu J, Balliet D, Van Lange PAM. 2016a. Gossip versus punishment: the efficiency of reputation to promote and maintain cooperation. *Sci. Rep.* 6:23919
- Wu J, Balliet D, Van Lange PAM. 2016b. Reputation management: why and how gossip enhances generosity. *Evol. Hum. Behav.* 37:193–201
- Yamagishi T. 1986. The provision of a sanctioning system as a public good. *J. Pers. Soc. Psychol.* 51:110–16
- Yamagishi T, Jin N, Kiyonari T. 1999. Bounded generalized reciprocity: ingroup favoritism and ingroup boasting. *Adv. Group Proc.* 16:161–97
- Yoeli E, Hoffman M, Rand DG, Nowak MA. 2013. Powering up with indirect reciprocity in a large-scale field experiment. *PNAS* 110(2):10424–29
- Zhang L, Tao Y, Shen M, Fairley CK, Guo Y. 2020. Can self-imposed prevention measures mitigate the COVID-19 epidemic? *PLOS Med.* 17(7):e1003240



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