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The ecological rationality of helping others: Potential helpers integrate cues of recipients' need and willingness to sacrifice

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ABSTRACT

Why do humans help others? Many theories focus on dimensions like kinship or reciprocity. On their surface, these theories seem unable to explain help directed at fleeting strangers. In response to this puzzle, researchers have proposed that the mind has *ecologically rational* systems for providing aid. These systems respond to cues that predicted adaptive behavior during human evolution, regardless of whether such cues continue to be predictive in modern environments. In three studies, we test for two cues that might predict whether a potential benefactor will help a potential recipient: the *need* of the recipient and the extent to which the recipient is *willing to sacrifice* for the benefactor. Both cues, in ancestral environments, have the potential to predict whether a long-term relationship might be established. Consistent with past research, we find that both cues matter: Needy people and people willing to sacrifice are helped more. However, the cues are not merely additive: In some cases, the cue of need is ignored and only willingness to sacrifice is used. We discuss these results in terms of recent evolutionary theories of emotions.

1. Introduction

Why do humans so willingly share resources with others, in ways unprecedented among other animals? We send money to victims of natural disaster half a world away. We donate to local charities to create children's hospitals. We give cash to the homeless family standing on the street corner. One type of explanation for these behaviors is that human generosity arises from a cue-driven, ecologically rational psychology that is designed for long-term cooperation and that evolved because of its positive feedback on the fitness of its bearer (Balliet, Tybur, & Van Lange, 2017; Delton & Robertson, 2016; Romano & Balliet, 2017; Todd, Gigerenzer, & the ABC Research Group, 2012; Tooby & Cosmides, 1996). But which cues does the mind use? And how are those cues integrated or traded off against one another?

Here we investigate two candidate cues for deciding whether to sacrifice personal welfare to benefit someone else: the other's need level and the other's willingness to sacrifice for the potential helper. Examining how multiple cues are combined is an important research question. Although there are decades of research studying particular cues to genetic relatedness, mate value, desirability as a cooperative partner, and so on, there is comparatively little research studying how multiple cues are combined and integrated in decision making, despite this being a necessary and important step (Conroy-Beam, 2018; Conroy-Beam & Buss, 2016; Delton & Robertson, 2016; Hackman, Danvers, & Hruschka, 2015; Lieberman, Tooby, & Cosmides, 2007; Pietraszewski & Shaw, 2015). We conducted three experiments employing a consequential monetary task to measure participants' willingness to benefit another individual at a personal cost. We tested how two cues are integrated: whether the potential recipient of aid is in need and whether the potential recipient is willing to sacrifice for their benefactor.

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1.1. Understanding sources of human generosity

There are many sources of human generosity. For example, selection for inclusive fitness benefits (Hamilton, 1964) has crafted psychological mechanisms that track cues to genetic relatedness and use them to regulate altruism (DeBruine, 2002; Kurland & Gaulin, 2005; Lieberman et al., 2007; Sznycer, De Smet, Billingsley, & Lieberman, 2016). Competition to attract high quality cooperative partners in a biological market (Noe & Hammerstein, 1995; Nowak & Sigmund, 2005) has crafted psychologies that are sensitive to the possibility of demonstrating one's generosity to others, to build a reputation as a valuable cooperator and signal it to potential partners (Barclay, 2004, 2016).

An important source of human generosity revolves around capturing the benefits of long-term relationships among individuals who are not closely related genetically. For instance, theories of *reciprocity* propose that individuals can mutually benefit by trading the provision of benefits back and forth over time (Trivers, 1971). Importantly, this requires that the relationship be sustained into the indefinite future (Axelrod & Hamilton, 1981). The shadow of the future makes it ecologically rational for organisms to cooperate, rather than cheat or exploit each other. In part, this is because an act of defection now lowers the probability of receiving a stream of benefits in the future if one's partner responds to defection in kind (Delton, Krasnow, Cosmides, & Tooby, 2011). Decades of research show that the human mind has a complex psychology for enabling exchange, trade, and reciprocity (Cosmides & Tooby, 1992, 2015).

Other theories focus on how cooperative partners can become *intrinsically* valuable to each other (Tooby & Cosmides, 1996). In this type of relationship, it is not the mere shadow of the future that maintains a relationship's profitability, but something specific to the relationship. For instance, the partners may, over years of interaction, have come to know each other so well that coordination is seamless, in ways unlikely to be easily replaced. Or they may share a similar worldview, making their interests converge in a way that would be hard to replicate with others. Such intrinsic value can lead to generosity even when the shadow of the future is short, such as when a partner is grievously ill. Such a selection pressure may explain the psychology of “emotional closeness” and its relationship to generosity and cooperation (Hackman et al., 2015; Kruger, 2003).

Another important source of human generosity is *risk pooling* (e.g., Gurven, 2004; Kameda, Takezawa, Tindale, & Smith, 2002; Kaplan & Hill, 1985; Kaplan, Hill, Lancaster, & Hurtado, 2000). This type of sharing system is designed to mitigate the risk inherent to a foraging life, especially one involving large package, calorie dense, but hard to acquire resources like meat. The logic of a risk pooling system can be seen in the following: On some days, a forager may not find sufficient food to meet their own energetic needs or the needs of their family. But another forager may have had better luck, finding more food than they can reasonably eat before it spoils. By sharing this excess, the lucky forager can provide a substantial benefit to the unlucky forager at a small incremental cost. Importantly, on different days the roles might be reversed, allowing both parties to benefit from sharing and smoothing out their consumption. The benefits of this system are even greater when, beyond mere bad luck, injury and illness are considered. Injury and illness can debilitate a forager for days or weeks (Bailey, 1991;Sugiyama, 2004a, 2004b; Sugiyama & Chacon, 2000). A study of Shiwiar hunter-horticulturalists in the Ecuadorian Amazon showed that 60% of the sample would have died had they not been part of a risk pooling system (Sugiyama, 2004a, 2004b; Sugiyama & Chacon, 2000). It is specifically when a person is in need that aid from another person is most valuable. As with reciprocity, risk pooling depends on established relationships to prevent individuals from cheating or exploiting each other.

1.2. Explaining puzzles of human generosity

But none of these accounts seems capable of explaining many types of generosity: sending money to victims of disaster, donating to charity, or giving cash to the homeless. Consider helping a stranger in distress: The helper and helpee are unlikely to be related or to expect to see each other again, nor may passersby take much notice. This act of generosity appears—on its surface—to be unlikely to have arisen from adaptations for helping kin, initiating a reciprocal relationship, or signaling generosity to third parties. It appears to arise from a proximate motivation to ameliorate the other person's need. In fact, decades of psychological research show that people often help in ways that, at the proximate level, are targeted primarily at relieving another's need. This is true even when there appears to be no rational way for the helper herself to receive any benefits in return for the aid she provides (Batson, O'Quin, Fultz, Vanderplas, & Isen, 1983; Goetz, Keltner, & Simon-Thomas, 2010).

Why do people help in ways that appear driven by others' needs? Like other psychological abilities that function to deliver benefits to others, need-based helping requires an evolutionary explanation (Aktipis et al., 2018; Tooby & Cosmides, 1996); adaptations for helping others cannot evolve unless they produce benefits sufficient to offset the costs of helping. Here, we test predictions from the hypothesis that such generosity is driven by an ecologically rational psychology that is searching for potential long-term relationships. Being in need, by definition, is a circumstance when aid would be especially valuable to the needy person. Helping a person in need may indicate that the helper values the person in need. If the needy person is not already an associate, then helping may function as an overture to a new relationship (see also Smith, Pedersen, Forster, McCullough, & Lieberman, 2017). If it develops, this relationship may generate the offsetting benefits that make the initial helping profitable.

Thus, on this hypothesis, helping of strangers arises, in part, from a psychology that functions to turn strangers into long-term associates. So, despite appearances, such generosity might be driven by adaptations created by selection for friendship and reciprocity. As we describe below, this psychology should be particularly sensitive to cues that a stranger values the helper's welfare.

Importantly, the mind was designed by the average consequences of natural selection in ancestral environments, and so it is not necessarily guided by information about the prospective profitability of a potential relationship that is actuarially rational in the present (e.g., the likelihood that a relationship will endure is slim for strangers encountering each other in a big city). But the mind's mechanisms may be ecologically rational (Gigerenzer, Todd, & the ABC Research Group, 1999; Krasnow & Delton, 2016; Krasnow, Delton, Cosmides, & Tooby, 2016; Todd et al., 2012). In an ecologically rational mind, psychological mechanisms are triggered by the presence of cues associated with ancestral challenges and opportunities. For example, strangers encountering each other for the first time in ancestral environments were more likely to meet each other again than are strangers in modern mass societies; human psychology may embody the ancestral regularity and treat strangers as if they would be seen again (Delton et al., 2011; Krasnow, Delton, Tooby, & Cosmides, 2013).

In the case of helping strangers, the cost of mis-categorizing a truly cooperative partner as non-cooperative (passing up the multiple benefits of an enduring relationship) would often have been higher than the cost of mis-categorizing a non-cooperative partner as cooperative (helping one or few times with no reciprocation). For this reason, our motivational systems may be designed to cooperate with high probability when one meets an individual for the first time (Delton et al., 2011; Krasnow et al., 2013; Rand, Greene, & Nowak, 2012; Yamagishi & Kiyonari, 2000; Yamagishi, Terai, Kiyonari, Mifune, & Kanazawa, 2007). This default probability of cooperation may be even higher when those strangers are in need, because need increases the cost-effectiveness of help. For example, by foregoing some of your extra food

you may save the life of a starving person.

Need may also generate common knowledge (cf. Pinker, Nowak, & Lee, 2008; Thomas, DeScioli, Haque, & Pinker, 2014), allowing two people without a preexisting relationship to jointly consider that a relationship may now begin. People soliciting aid while in need may be signaling that they are open to forming a new relationship; people who help a needy individual may be indicating their willingness to attempt a new relationship. Of course, the joint attention generated by the need does not by itself guarantee that the actors will establish a relationship, let alone a mutualistic relationship.

But is being in need always a useful cue that a relationship is in the offing? Not all people who might benefit from aid are willing to accept aid, perhaps because they do not view a relationship with the helper as beneficial (Ackerman & Kenrick, 2008). Or they may refuse if receiving aid is perceived as creating unwanted obligations or lessening their social status (Foster, 1972; Schoeck, 1969; Tracer, 2004). Conversely, people in need do not always receive help and are not always targets of compassion. Helping is more strongly elicited by pleas to aid a single individual than by pleas to aid thousands of anonymous people (Slovic, 2007); although an ongoing relationship is possible with a specific other, it is not with an anonymous mass of humanity. Compassion does not always predict helping members of outgroups (Stürmer, Snyder, Kropp, & Siem, 2006; Stürmer, Snyder, & Omoto, 2005); a productive relationship is less likely if a person is from a competing or antagonistic outgroup. Compassionate behavior is also less likely toward people who have low value as cooperation partners (Batson, Eklund, Chermok, Hoyt, & Ortiz, 2007; Petersen, Sell, Tooby, & Cosmides, 2012; Petersen, Sznycer, Cosmides, & Tooby, 2012; Sole, Marton, & Hornstein, 1975); beginning a relationship with such people would not be cost-effective.

The above argument suggests that although need is sometimes a cue to the possibility of forming a new relationship, it is not the only one. Theories of ecological rationality emphasize that not all cues are created equal. Although a particular cue may be used when it is the only one available, it might be discounted or ignored when other, better cues are present (for an example regarding kin detection and the differential use of available kin cues, see Lieberman et al., 2007; Sznycer et al., 2016). In the domain of cooperation and punishment, people use (at least) two cues to regulate punishment: whether a person treats *others* poorly (e.g., by not sharing resources with them) and whether that person treats the *self* poorly. Krasnow et al. (2016) found that when other-directed treatment was the only available cue, poor treatment of others predicted punishment. But when cues of self-directed and other-directed treatment were both available, poor treatment of the self predicted punishment entirely; other-directed treatment no longer had any predictive value (Krasnow et al., 2016).

Cues of need may signal an opportunity to initiate a new relationship by demonstrating goodwill. But everyone needs help at some point, whether they are valuable long-term cooperative partners, well-intentioned but unproductive partners, or exploitive partners. If helping strangers is caused, in part, by adaptations for partner choice, an ecologically rational mind will respond with generosity to cues that the stranger would be a valuable long-term cooperative partner. Cues of partner quality, including perceptions of a stranger's health and productivity as a forager, are known to elicit generosity toward strangers in ultimatum games, in a way suggesting that participants are bidding for valuable cooperative partners (Eisenbruch, Grillot, Maestripieri, & Roney, 2016). None of these traits are important, however, unless the stranger is likely to value *your* welfare. A cue that can signal this person-specific quality is how willing the stranger is to sacrifice for you.

A burgeoning area of research has been investigating how the mind determines how much to sacrifice for someone else. This research shows that the mind has the ability to estimate how willing others are to sacrifice for oneself and that these estimates are used to regulate consequential altruistic behavior (Delton & Robertson, 2016; Delton & Sell, 2014; Lim, 2012; Petersen, Sznycer, Sell, Tooby, & Cosmides, 2013; Sell, Tooby, & Cosmides, 2009; Sznycer, 2010).

However, this research has not examined how the mind makes decisions when it has information both about another person's need and their willingness to sacrifice for their potential benefactor. Do both cues influence generosity toward strangers? If so, how are they integrated? Are their effects additive, producing the most generosity toward needy strangers who are also willing to sacrifice to help you? Or are these cues integrated via a non-compensatory algorithm, like the cases of kin detection and punishment discussed above? For example, is evidence that a stranger is willing to sacrifice to help you such a reliable cue of their value as a long-term cooperative partner that it elicits generosity from you, regardless of how needy they are?

The research herein addresses these questions about cues and their integration. We ask whether generosity toward strangers is elicited by both cues—the stranger's need and her willingness to sacrifice to help you—and, if so, how and when they are integrated.

1.3. The present research

Here we are defining generosity as one's willingness to sacrifice to provide benefits to another individual. When encountering a person who is not already an associate, the hypothesis that one's generosity is regulated by adaptations for initiating long term cooperative relationships makes several predictions.

First, when need level is the only cue available, people will sacrifice more to help needier people (consistent with past research).

Second, people will sacrifice more to help strangers when there are cues that the stranger values their welfare. A straightforward prediction from many theories about the evolution of cooperation is that a stranger who is highly willing to sacrifice to help you is likely to be a good long-term cooperative partner, whether that stranger is needy or not. Evidence of high willingness to sacrifice should, therefore, upregulate one's own willingness to help that stranger.

Third, high willingness to sacrifice is a more reliable cue of the stranger's value as a long-term cooperator than their being in need, because everyone—cooperators and cheaters alike—eventually experiences need. This implies that generosity will be upregulated strongly by high willingness to cooperate, and this cue should dominate, reducing or perhaps eliminating the effect of cues indicating high need.

Fourth, the lowest levels of generosity toward strangers will be elicited when their behavioral profile indicates low need paired with unwillingness to sacrifice to help you. Being unwilling to incur costs to help when she can afford to do so should be an ecologically valid cue that the stranger does not value your welfare, and would therefore be a poor choice as a long term cooperative partner.

An ecologically rational mind should not, however, classify all unwilling strangers as poor long-term partners. When the stranger is needy, low willingness to sacrifice to help you is an unreliable cue to their future value as a cooperative partner. The stranger may be unwilling to incur costs to help you because their short-run need is so dire that they cannot afford to be generous. The inference that this needy stranger does not value your welfare is further undercut by the fact that the marginal benefit of each unit of a resource is higher for a person in need (compared to a low need person) (see Sell et al., 2017). Unwillingness to sacrifice is an ambiguous cue under these circumstances; it need not imply that the stranger does not value your welfare.

This analysis leads to our fifth prediction. Cues of high need may elicit more generosity toward a stranger who was unwilling to sacrifice to help you, relative to an unwilling, low need stranger, because a needy stranger's failure to incur costs to benefit you does not support strong inferences about her value as a future cooperative partner. Moreover, helping the needy person may restore her ability to provide benefits to you and others in the future. The attitude of a needy unwilling stranger is uncertain, however. Needy unwilling strangers have not provided positive evidence that they value your welfare, so they should elicit less generosity than needy strangers who demonstrated that they are willing to incur costs to help you.

Statistically, the predictions above can be summarized as follows: In explaining participants' willingness to sacrifice for the stranger, there will be main effects of the stranger's (*i*) need and (*ii*) willingness to sacrifice for the participant, as well as a stranger need-by-sacrifice interaction.

We tested these predictions in three laboratory experiments. In all experiments, participants had the opportunity to provide, at a personal cost, benefits to a stranger whom they are ostensibly paired with over the laboratory computer network (in fact, the stranger was experimentally simulated). We used a technique that involves assessing how much personal money participants would forgo in order to deliver a fixed sum of money to the stranger (e.g., would participants forgo $24 to deliver $19 to the stranger? $16 to deliver $19? $5 to deliver $19?). This served as our measure of willingness to sacrifice.

In Study 1, the only cue that participants have access to is the stranger's need level. Participants read a brief paragraph written by the stranger that describes their recent life. In the low need condition, the stranger is living a normal, happy life. In the high need condition, the stranger has experienced costly medical difficulties recently that are making completing school difficult. In Study 2, participants continue to receive information about the stranger's need, but now they also receive information about the stranger's willingness to sacrifice for them. Prior to making decisions about sacrificing money to give to the stranger, participants see a series of decisions that the stranger made regarding the participant. In the low willingness-to-sacrifice condition, the stranger is not willing to sacrifice on behalf of the participant. In the high willingness-to-sacrifice condition, the stranger is willing to sacrifice a lot. Study 3 replicates the manipulation of the stranger's willingness to sacrifice.

One feature of our measure of participants' generosity bears emphasizing, in contrast to past studies. In past work, the amount of help *given* and the amount *spent to give* often perfectly covary: If I give you a dollar, I necessarily lose that dollar; if I give you an hour of my time, I necessarily lose that hour. Our measure breaks this connection: We assessed how much participants would be willing to sacrifice *while holding constant the amount the other person would receive*. Thus, even if it turns out that the cues of need and willingness to sacrifice by a stranger are merely additive, showing the effects of these cues on a measure that de-confounds amount given and amount spent to give is still useful.

In all three studies we measured participants' compassion for the stranger as a manipulation check of the need manipulation. Decades of research on compassion has shown it to be reliably activated when people recognize that another person is in need, and that compassion is typically associated with efforts to alleviate the need (Batson et al., 1983; Goetz et al., 2010). We do not include a manipulation check of the willingness-to-sacrifice manipulation, but other research has found that the mind is sensitive to it (Delton & Robertson, 2012; Lim, 2012).

2. Study 1

Study 1 tests whether need, when it is the only cue available, predicts generosity—willingness to sacrifice—on behalf of a stranger. Past research has shown that high need induces helping or generosity (e.g., Delton, Petersen, DeScioli, & Robertson, in press; Goetz et al., 2010). One way in which our studies differ from past studies is that typically the amount of *help provided* and the *cost incurred to provide the help* are conflated. For example, if the type of help needed involves a time commitment, then more help is necessarily conflated with the cost of the help (i.e., both are the amount of time actually given). In contrast, our measure assesses how much participants are willing to sacrifice to deliver a benefit of fixed size. To do this, we used an instrument that measures the output of a computational system that regulates welfare tradeoffs. For a given situation, this system computes how much personal welfare one is willing to sacrifice to enhance the welfare of another, specific, individual (Delton & Krasnow, 2017; Kirkpatrick, Delton, Robertson, & de Wit, 2015; Krasnow et al., 2016; Smith et al., 2017). The instrument provides a handy way to compare people's willingness to sacrifice for another while holding the benefit delivered constant, as a price or ratio: (amount forgone by decider)/(fixed amount obtained by recipient). (See the General discussion for more detail on welfare tradeoff functions.)

2.1. Method

2.1.1. Participants and design

We analyzed data from 132 university students (78 women) who participated for course credit (mean age: 20 years old, SD = 2). In the experiment, participants were ostensibly paired with a stranger and interacted with them through a computer. They learned whether the stranger was or was not experiencing need in their life outside the lab. Participants then rated their experience of several emotions, including a series of items designed to measure their compassion. Finally, they completed the task that assessed their willingness to sacrifice personal benefits to deliver a benefit of fixed size to the stranger. To convey the participant's perspective, throughout the paper we will refer to participants as being “paired” with a stranger. However, note that in all cases this actually meant participants interacting with a computer-mediated, sham partner.

Data from an additional 31 participants were not analyzed because they were suspicious about the existence of an actual partner. Inclusion of the suspicious participants does not change the statistical significance of the results, except when noted. Our plan from the outset was both to exclude suspicious participants from analysis and to also compare the full sample with suspicious participants to the main sample reported here.

2.1.2. Procedure

Participants completed the study in groups of up to ten same-sex people in a large room with semi-private cubicles. They were told that they would be interacting over the computer with one other person in the room (“the stranger”), but that they would never learn this person's identity. In fact, there were no interactions; the computer determined all the responses by the supposed stranger.

First, the computer asked participants to write a brief passage about their own lives. Then, participants read the stranger's passage, while their own passage was ostensibly read by the stranger. Participants knew in advance their passage would be shared. The stranger's passage served as a between-subjects manipulation of need. The *high need* passage indicated that the stranger was sick for most of last school year and, although they are recovered now, they have too many courses to complete in a short time because they lack the money to take an extra year to graduate. The *low need* passage indicated that the stranger is happy, enjoys hanging out with their friends, and is planning for a study abroad program (see online supplemental materials). In the experiment, the stranger was referred to with a common name (e.g., John), ostensibly made up for identification.

Next, participants rated a series of emotion terms, in which were embedded terms to assess compassion (after, e.g., Batson, Turk, Shaw, & Klein, 1995; Maner et al., 2003). For each term, participants answered, “How much did you experience this emotion while reading the statement from [the stranger]?” (1 = not at all; 7 = extremely). The compassion scale emotions were “sympathetic”, “compassionate”, “soft-hearted”, “warm”, “tender”, and “moved” (6 items; $\alpha = 0.82$). We also included 15 additional filler items, including “proud,” “amused,” and “bored”. All terms were randomly intermixed; thus, participants did not experience discrete sets of emotion terms.

Willingness to sacrifice was measured with 10 dichotomous decisions (see Table 1). For example, do you prefer to allocate $5 to yourself or $19 to the stranger? $20 to yourself or $19 to the stranger? The order of the decisions was randomized separately for each participant. Participants were asked to make each decision as if it was the only decision they were making. Further, they were instructed that neither they nor

Table 1
Decisions faced by participants (amounts in $).

Study 1		Studies 2 and 3	
Self	Other	Self	Other
28	19	26	21
24	19	22	21
20	19	18	21
16	19	14	21
12	19	9	21
9	19	7	21
5	19	5	21
1	19	3	21
−3	19	1	21
−7	19	−2	21

Note. Each row represents one decision made by the participant. For each decision, the participant has to choose between an amount of money for themselves and an amount of money for the other. Foregoing a positive sum for the self to deliver money to the other implies a positive welfare tradeoff ratio. Choosing a negative amount for the self implies a negative (spiteful) welfare tradeoff ratio—it means the participant pays money (from their $7 endowment in Study 1; from their $2 endowment in Studies 2 and 3) to prevent the other from getting money.

the stranger could share the money with the other, and that "neither the other person nor anyone else will know what choices you make."

We analyzed participants' responses using a previously established method, which measures how much personal welfare the participant is willing to sacrifice to give a fixed amount to the stranger (Delton & Krasnow, 2017; Kirkpatrick et al., 2015; Krasnow et al., 2016). To compare differences across participants, the price the participant is willing to pay to deliver a benefit of fixed-size X is expressed as a ratio: (amount forgone) / (benefit X). Possible scores—welfare tradeoff ratios—given the instrument used here range from −0.47 to 1.58. A welfare tradeoff ratio of 0.5, for example, would imply the participant is willing to forego half as much personal welfare when giving a fixed amount to the other person. For example, if the fixed amount for the stranger is $19, a participant with a welfare tradeoff score of 0.5 would sacrifice up to $9.50 to give to the stranger ($9.50 = 0.5 ∗ $19). A welfare tradeoff ratio of −0.25 would imply the participant is willing to *pay* up to $4.75 rather than allocate $19 to the stranger (−$4.75 = −0.25 ∗ $19). Larger welfare tradeoff ratios represent a greater willingness to sacrifice personal benefits to deliver a fixed benefit to the stranger.

The sacrifice choices were probabilistically paid out. Participants rolled two dice at the end of the study and, if they obtained double-sixes, one randomly selected decision was actualized. Some choices required participants to *pay* as much as $7 to prevent the other from receiving money. To prevent participants from paying money out of their pockets, those who rolled double-sixes were given an endowment of $7 in addition to the sum indicated in their choice (thus, other-favoring choices did not yield participants any money beyond the $7 endowment). Participants had a 1 in 36 chance of making between $0 and $35 (including the $7 endowment) based on their choices. Last, participants were probed for suspicion regarding the sham partner.

2.2. Results and discussion

2.2.1. Does manipulated need increase compassion?

Yes. As shown in Table 2, participants felt more compassion toward a stranger in high need than in low need ($p < .001$). This suggests our manipulation of need was effectively recognized by participants.

2.2.2. Does manipulated need increase willingness to sacrifice?

Yes. As shown in Table 2, participants were more willing to sacrifice for strangers in high need than for strangers in low need ($p < .001$). Specifically, whereas in the low need condition participants would forgo about $5 to deliver $19 to their partner, in the high need condition they would forgo about $11 to deliver $19, a > 100% increase.

Table 2
Compassion and welfare tradeoff ratios by condition (Study 1).

	Stranger in low need	Stranger in high need	t	r
Compassion	2.26 (0.88)	4.03 (1.13)	9.98***	0.66
Welfare tradeoff ratios	0.26 (0.40)	0.60 (0.52)	4.16***	0.34

Note. Displayed are means, with standard deviations in parentheses. *r* is given as a measure of effect size.
*** $p < .001$.

2.2.3. Ancillary analysis: The relationship between compassion and sacrifice

For exploratory purposes, we analyzed whether the participant's compassion mediates the relationship between the stranger's need and the participant's willingness to sacrifice for the stranger. Participants' reported compassion correlated with their willingness to sacrifice ($r = 0.35$, $p < .001$). Compassion also statistically mediated the relationship between the manipulation of need and willingness to sacrifice. To test this we used a bootstrapping approach to mediation with 5000 bootstrapped samples and a 95% bias-corrected and accelerated confidence interval (Preacher & Hayes, 2008). Welfare tradeoff ratios were the dependent variable, manipulated need the independent variable, and compassion the mediator. Compassion significantly mediated the relationship between need and willingness to sacrifice (indirect estimate = 0.1401; 95% confidence interval = 0.0006 to 0.2804), and nearly eliminated the direct effect between need and sacrifice (for direct effect, $b = 0.20$, $p = .068$) (Fig. 1). The mediation effect through compassion accounted for 42% of the total effect. In other words, of the $6 increase in how much participants would sacrifice to deliver $19 to the needy stranger (compared to the stranger not in need), about $2.50 of that is statistically accounted for by ratings of compassion.

In sum, greater need—when need level is the only cue available—caused participants to sacrifice more to benefit a stranger. Greater need also caused more compassion, and compassion statistically mediated the effect of need on sacrifice. So far, this merely represents a replication of past findings on need and help, but with a measure that de-confounds the amount given and the cost to give. Our next study examines the more novel question of cue integration.

3. Study 2

Study 1 tested whether the cue of need predicts a person's

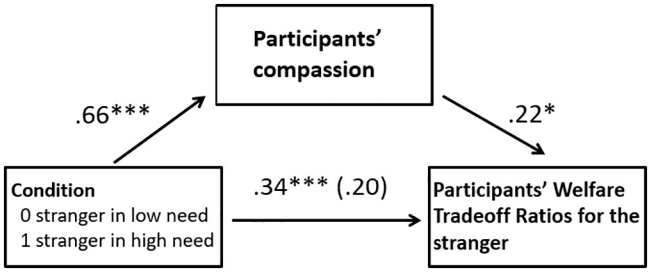

Fig. 1. The mediating effect of participants' compassion between stranger's need level and participants' Welfare Tradeoff Ratios for the stranger (Study 1) Standardized regression coefficients are presented. On the bottom path, the value outside the parentheses represents the standardized regression coefficient before including the mediating variable (i.e., the total effect), whereas the value between parentheses indicates the standardized regression coefficient in the final model (i.e., the direct effect). Asterisks indicate the significance of the coefficients (*$p < .05$, ***$p < .001$).

willingness to sacrifice for a stranger *in the absence of information about the stranger's willingness to sacrifice for their potential helper*. In Study 2 we gave people additional information about how much the stranger would sacrifice for them. To experimentally manipulate the stranger's willingness to sacrifice for the participant, we showed participants a version of the sacrifice task as answered by the stranger. (As with the version participants filled out, the version the stranger filled out manipulated the amount the stranger could pass up while holding constant the amount given to the participant.)

By crossing cues of high versus low need with cues of high versus low willingness to sacrifice, we can see whether both cues regulate generosity toward strangers. This design can also reveal how these cues are integrated. It can show whether the effects of these cues are additive or not. High willingness to sacrifice is predicted to be a particularly strong cue of the stranger's potential as a long-term cooperative partner, more diagnostic than the stranger's need. If the cues are not additive, we expect that cues indicating the stranger is willing to incur costs to benefit the participant will elicit high levels of generosity, in a way that attenuates—or eliminates—the effect of need as a cue.

3.1. Method

3.1.1. Participants and design

We collected and analyzed data from 156 university students (91 women) who participated for course credit. Mean age was 19 years old (SD = 1). Data from an additional 14 participants were not analyzed because they were suspicious about the existence of the stranger. There were two between-subjects manipulations: Participants interacted with a (sham) stranger in high or low need. Independent of this, the stranger revealed a high or low welfare tradeoff ratio (i.e., willingness to sacrifice) for the participant.

3.1.2. Procedure

The procedure was largely identical to Study 1, except for the following changes. First, participants completed a baseline sacrifice task regarding the stranger after writing their autobiographical passage but before receiving the stranger's passage. That is, participants completed 10 dichotomous money-allocation decisions at the outset so that we could determine participants' welfare tradeoff ratios toward the stranger *before participants learned anything substantial about the stranger*. This allowed us to control for preexisting differences in how generous participants are on this task.

Second, after reading the stranger's passage and rating their own emotions, but before completing the final sacrifice task, participants were told the stranger had made a similar series of sacrifice decisions with respect to the participants. The participants then viewed all 10 choices the stranger made toward them, revealing either a high or a low willingness to sacrifice; the choices implied that the stranger's welfare tradeoff ratio for the participant was either 0.8 or 0.0. Importantly, despite this large difference in welfare tradeoff ratios, the objective *amount* of money participants received from the stranger on a decision by decision basis, and in total, was held constant across conditions ($0 for five decisions, $24 for the other five). This was done by varying between conditions the amounts in the decision sets strangers faced; see Table 3. In the low willingness-to-sacrifice condition, the stranger allocated to the participants only when the alternative was for themselves to lose money; the stranger failed to forgo even a small amount to benefit participants by a relatively large amount. In the high willingness-to-sacrifice condition, by contrast, the stranger was quite willing to forgo money to give money to the participants.

The third change was that the baseline and final willingness-to-sacrifice tasks that participants completed had slightly different ranges than in Study 1; sacrifice scores now could range from −0.17 to 1.34 (the only spiteful choice now required participants to pay $2, so an endowment of $2 was given to those who rolled double-sixes) (see Table 1).

Table 3
Sacrifice decisions made by the stranger in Studies 2 and 3 (amounts in $).

Welfare tradeoff ratios implied by the stranger's decisions: **0.8** (**high**)			Welfare tradeoff ratios implied by the stranger's decisions: **0.0** (**low**)		
Stranger	Participant	Stranger chooses…	Stranger	Participant	Stranger chooses…
31	24	Stranger	107	24	Stranger
29	24	Stranger	11	24	Stranger
26	24	Stranger	7	24	Stranger
24	24	Stranger	5	24	Stranger
22	24	Stranger	2	24	Stranger
17	24	Participant	−2	24	Participant
12	24	Participant	−5	24	Participant
7	24	Participant	−7	24	Participant
2	24	Participant	−10	24	Participant
−2	24	Participant	−12	24	Participant
Mean amount when stranger keeps: **$26.40**			Mean amount when stranger keeps: **$26.40**		
Mean amount when stranger gives: **$24**			Mean amount when stranger gives: **$24**		

Note. Each row represents one decision made by the stranger. For each decision, the stranger has to choose between an amount of money for themselves and an amount of money for the participant. The mean amounts kept by the stranger and given to the participant when the stranger chooses "stranger" and "participant" are the same across conditions. However, in the low welfare tradeoff ratio (0.0) condition the stranger does not incur any costs when passing money to the participant—they transfer money only when the alternative is for themselves to lose money. In contrast, in the high welfare tradeoff ratio (0.8) condition, the stranger often incurs costs when transferring money to the participant; they pass money even when the alternative is to benefit themselves.

We note that the emotion questions were asked immediately after participants read the stranger's passage (i.e., participants' compassion ($\alpha = 0.87$) was measured immediately after participants learned about the stranger's need level).

3.2. Results and discussion

3.2.1. Was compassion greater for a stranger in need?

Yes. Recall that compassion was measured right after participants received the information concerning the stranger's need but before seeing how the stranger completed their sacrifice task. Compared to a stranger who was not in need (M = 2.33, SD = 1.11), the stranger in need elicited more compassion (M = 4.27, SD = 1.35; $t_{154} = -9.76$, $p < .001$, $r = 0.62$; we use r as a measure of effect size for difference tests so that effect sizes are more comparable across different tests.)

3.2.2. Which was a stronger predictor of participants' willingness to sacrifice, the strangers' willingness to sacrifice or the strangers' need?

Recall that strangers revealed their willingness to sacrifice after participants learned of their need but before participants made their second sacrifice decisions. The theory outlined above predicts that participants' willingness to sacrifice will be upregulated by cues that the stranger is willing to sacrifice for the participant; when this is true, the effect of the stranger's need may be attenuated or eliminated.

We first analyzed participants welfare tradeoff ratios for the stranger using a 2×2 between-subjects analysis of covariance (ANCOVA) controlling for the participant's baseline willingness to sacrifice. As predicted, there was a large main effect of the stranger's willingness to sacrifice ($F(1,151) = 56.33$, $p < .001$, partial $\eta^2 = 0.27$). However, there was no main effect of the stranger's need ($F(1,151) = 0.78$, $p = .38$, partial $\eta^2 = 0.005$).

Once the stranger's willingness to sacrifice is observed, need does not matter much. Whereas participants paired with a stranger sacrificing nothing (0.0 welfare tradeoff ratio condition) were willing to forgo $6 to deliver $21 to the stranger, participants paired with a partner sacrificing a lot (0.8 welfare tradeoff ratio condition) were willing to forgo more than twice as much, passing up $13 to deliver $21.

As predicted, the ANCOVA also revealed an interaction that trended toward significance ($F(1,151) = 2.66$, $p = .10$, partial $\eta^2 = 0.017$); see Fig. 2. Perhaps the stranger's need does continue to matter when there is uncertainty about how much the stranger values your welfare. To explore this interaction, we analyzed the effect of the stranger's need separately for the high (0.8) and low (0.0) welfare tradeoff ratio conditions. In the high welfare tradeoff ratio condition, there was no effect of the stranger's need on participants' willingness to sacrifice for the stranger (controlling for the participant's baseline willingness to sacrifice; $F(1,76) = 0.18$, $p = .67$, partial $\eta^2 = 0.002$). In fact, the trend was in the opposite direction (slightly more sacrifice for the stranger not in need). When the stranger is very willing to sacrifice, their need does not appear to matter.

Turning to the low welfare tradeoff ratio condition, we find that participants sacrificed more when the stranger was in high need compared to low need (the two leftmost bars in Fig. 2; controlling for the participant's baseline willingness to sacrifice; $F(1,74) = 4.31$, $p = .041$, partial $\eta^2 = 0.055$). This is consistent with past work showing that people will be generous to stingy others, so long as they are induced to feel empathy for the stingy person (Batson & Ahmad, 2001). It is also consistent with our conjecture above: Strangers in high need may be too disadvantaged to sacrifice for the participant, so low willingness is an ambiguous cue to how much a stranger in need values your welfare.

Although the need cue upregulated participant's willingness to sacrifice for strangers in the low willingness condition, they sacrificed even more for strangers in the high willingness condition, where need played no role in their decisions (controlling for the participant's baseline willingness to sacrifice; high need, low willingness vs. low need, low willingness; $F(1,74) = 4.31$, $p = .041$, partial $\eta^2 = 0.055$; low need, high willingness vs. low need, low willingness; $F(1,72) = 55.40$, $p < .001$, partial $\eta^2 = 0.43$). That is, high willingness—regardless of need—produced a larger upregulation in sacrifice by participants than the high need of strangers who did not sacrifice benefits to benefit the participant.

To clarify these findings we conducted additional exploratory analyses. These analyses also help test against an alternative hypothesis: When the stranger reveals their welfare tradeoff ratio, they are also providing additional information about whether they are truly in need.[2] For instance, a person in high need who is not generous may be exceptionally needy; a person ostensibly in high need who is also generous may not really be in high need. Although we think this is in principle possible, it does not seem to be driving the data much or at all.

First, we find that the low welfare tradeoff ratio condition did not simply replicate Study 1: When a stranger in high need was unwilling to sacrifice for the participant, it did reduce the participant's willingness to sacrifice. To show this, we compared participants' welfare tradeoff ratios from Study 2 *when the stranger was both high in need and not willing to sacrifice* (M = 0.38, SD = 0.39; second welfare tradeoff ratio) with participants' welfare tradeoff ratios from Study 1 *when the stranger was high in need and information on willingness to sacrifice was unavailable* (M = 0.60, SD = 0.52). Participants were less willing to sacrifice when they knew that the stranger would not sacrifice for them, even though need was high in both cases ($t_{105} = -2.26$, $p = .026$, $r = 0.22$). The alternative hypothesis would have predicted the opposite pattern: A person in high need who was not generous should have been seen as especially needy and given *more* help than a person who was merely in high need; this is not what we observed.

Indeed, participants' willingness to sacrifice for high need strangers who demonstrated high willingness to sacrifice for the participant was about the same as their willingness to sacrifice for high need strangers whose willingness to sacrifice was unknown. Participants' welfare tradeoff ratios from Study 2 *when the stranger was both high in need and willing to sacrifice* (M = 0.57, SD = 0.41; second welfare tradeoff ratio) was similar to participants' welfare tradeoff ratios from Study 1 *when the stranger was high in need and information on willingness to sacrifice was unavailable* (M = 0.60, SD = 0.52); $t_{112} = 0.32$, $p = .75$, $r = 0.03$. The alternative hypothesis would have predicted that being generous while in high need undercuts one's claim to being in need, thereby eliciting less generosity from the participant; that is not what we observed.

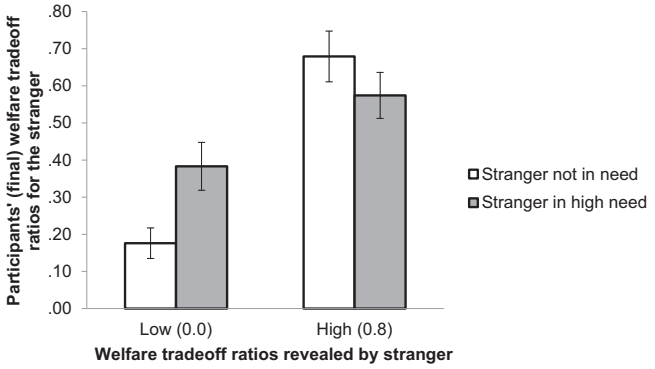

Fig. 2. Means of participants' (final) welfare tradeoff ratios for the stranger by stranger's need and stranger's welfare tradeoff ratios regarding the participants. Bars indicate standard errors. (Study 2).

Finally, further analyses showed that the effect of the stranger's welfare tradeoff ratio is significant both when the stranger's need is low (controlling for the participant's baseline willingness to sacrifice; $F(1,72) = 55.40$, $p < .0001$, partial $\eta^2 = 0.43$) and when the stranger's need is high (controlling for the participant's baseline willingness to sacrifice; $F(1,78) = 13.33$, $p = .0005$, partial $\eta^2 = 0.15$). Thus, in the conditions we studied, participants are uniformly more willing to sacrifice for a stranger who sacrifices for them, consistent with past research.

3.2.3. Ancillary analysis: The relationship between compassion and willingness to sacrifice

In Study 1, participants' compassion correlated with their willingness to sacrifice for the stranger. In Study 2, when participants have information about the strangers' willingness to sacrifice for the participants—and thus have information about the strangers' interest in a relationship—the correlation between participants' compassion and participants' willingness to sacrifice might be reduced or eliminated. This was the case: We analyzed separately participants paired with strangers revealing high willingness to sacrifice for the participants and participants paired with strangers revealing no willingness to sacrifice. In neither group was there a correlation between compassion and participants' willingness to sacrifice for the stranger (partial $rs = -0.01$ and 0.14, $ps \geq 0.22$, controlling for participants' baseline willingness to sacrifice).

3.3. Discussion

In sum, the results suggest that both the stranger's need and the stranger's willingness to sacrifice for the participant are cues regulating the participant's willingness to sacrifice to benefit the stranger. But their effects were not additive. The effect of the need cue was conditional, mattering only when the stranger was unwilling to sacrifice for the participant.

Consistent with the hypothesis that willingness to help strangers is produced by a motivational system designed for finding and attracting good long-term cooperative partners, participants were clearly more willing to sacrifice for a stranger who has sacrificed for them, whether the stranger was in need or not. High willingness to sacrifice indicates that the stranger values the welfare of the participant. It is a strong cue that the stranger is likely to be a good long-term cooperative partner.

The need cue played a role only when this strong cue was missing.

[2] We thank an anonymous reviewer for suggesting this alternative.

Strangers who could afford to sacrifice but did not—those in the unwilling, low need condition—elicited very little sacrifice from participants. Their behavior suggests they would make poor cooperative partners because they place little weight on the participant's welfare. This inference should be less certain, however, for unwilling strangers in need. Their unwillingness to sacrifice could result from desperate need, rather than from stinginess; it does not necessarily signal that they place a low value on the participant's welfare. Accordingly, strangers with this profile elicited more sacrifice than unwilling, low need strangers. They did not, however, elicit as much sacrifice as high need strangers who demonstrated their willingness to sacrifice to help the participant.

This pattern of cue use suggests that the motivational system activated integrates cues of cooperative partner value using a non-compensatory algorithm (similar to what Gigerenzer and colleagues call a "take the best" algorithm (e.g., Gigerenzer & Goldstein, 1996)). When the more reliable cue—high willingness—is present, the mechanism upregulates helping in response. When it is absent, the mechanism upregulates helping only for strangers in need—those whose low willingness might reflect dire need rather than poor quality as a cooperative partner.

4. Study 3

In Study 2 we found evidence that participants were more willing to sacrifice for a stranger in high need than low need *when that stranger was not willing to sacrifice for the participant*. However, the stranger's need level did not affect participants' sacrifice *when the stranger was willing to sacrifice a lot*. We interpret the latter effect to mean that, in this case, the mind adaptively privileges sacrifice information over need information. However, an alternative hypothesis for the latter, null effect of need is that the stranger's willingness to sacrifice was so unexpectedly high—in a way that may not occur in the real world—that it caused participants to forget or ignore need information. Recall that in Study 2 all participants first learned about the stranger's need level and then learned about the stranger's willingness to sacrifice for the participant, always in that order.

Study 3 allows us to test the hypothesis that decisions regarding sacrifices for a stranger are determined more by the stranger's sacrifice than by the stranger's need (the hypothesis motivating the present work) against the alternative hypothesis that such decisions are equally determined by the stranger's sacrifice and their need—an effect we would detect if information about the stranger's need was still available during decision-making.

As in Study 2, in Study 3 participants always learned about the stranger's need before learning about the stranger's sacrifice. Unlike in Study 2, however, in Study 3: (*i*) Participants only interacted with high need strangers and, in the key change, (*ii*) compassion was measured *after* participants learned about the stranger's sacrifice. In Study 3, the stranger's sacrifice is the only variable that is manipulated.

In Study 3, participants' need-tracking emotion of compassion (Goetz et al., 2010)—which is measured *after* participants learn about the stranger's sacrifice—should be relatively low if the alternative, "forgetting" hypothesis is true (i.e., if the unexpected, attention-grabbing nature of the stranger's sacrifice makes you forget the previous information about the stranger's need). However, if participants' compassion in Study 3 is high *even when strangers make high sacrifices for the participants*, this would imply that receiving high sacrifices from strangers does *not* cause participants to forget information about the strangers' need—the alternative hypothesis would be false. This latter outcome, if the data supported it, would indicate that decisions regarding sacrifices for a stranger are indeed determined more by the stranger's sacrifice than by the stranger's need.

On our hypothesis, participants in Study 3 can continue to recognize the high need—and continue to feel compassion—even though the decision-making machinery does not use this information when deciding how much to sacrifice in return. Study 3 also allows us to replicate the basic effect that participants will be more willing to sacrifice when the stranger is also more willing to sacrifice for them.

4.1. Method

We collected and analyzed data from 86 university students (61 women) who participated for course credit. We did not analyze data from seven people who were suspicious about the partner. Mean age was 19 years old (SD = 1).

This experiment was identical to Study 2, with two exceptions. First, everyone interacted with a stranger in high need. Second, participants rated the emotion items *after* learning the stranger's willingness to sacrifice. As before, there was a between-subjects manipulation of the stranger revealing a high or low willingness to sacrifice for the participants.

4.2. Results

4.2.1. Is willingness to sacrifice for the stranger reduced when they reveal a low rather than high willingness to sacrifice?

Yes. Replicating Study 2, participants expressed lower welfare tradeoff ratios toward the needy stranger who expressed low willingness to sacrifice (M = 0.43, SD = 0.44) than toward the needy stranger expressing a high willingness to sacrifice (M = 0.66, SD = 0.38) (controlling for their baseline welfare tradeoff ratio in an ANCOVA, $F(1,83) = 3.95$, $p = .05$, partial $\eta^2 = 0.045$; a medium-sized effect; we note that this test is marginally significant if one includes suspicious subjects). Participants paired with a partner revealing no willingness to sacrifice were willing to forgo about $9 to deliver $21, whereas participants paired with a partner revealing a high willingness to sacrifice were willing to forgo about $14 to deliver $21, an increase of about 50%.

4.2.2. Is compassion affected by learning the stranger's willingness to sacrifice for the participants?

On the alternative, "forgetting" hypothesis, compassion should be reduced when the stranger reveals a high, rather than low, willingness to sacrifice, because the participant forgot about the stranger's high need. Inconsistent with this, there was virtually no difference in compassion between conditions where the needy stranger revealed a low or a high willingness to sacrifice for the participant ($M_{Low} = 4.31$ and $SD_{Low} = 1.47$ versus $M_{High} = 4.22$ and $SD_{High} = 1.25$). An ANCOVA controlling for participants' baseline willingness to sacrifice confirms this, finding no significant difference in compassion ($F(1,83) = 0.07$, $p = .80$, partial $\eta^2 = 0.0008$).

Felt compassion was not affected by how the stranger treats the participant in this study. Future research using a broad array of circumstances is necessary to find out whether compassion always fails to track a stranger's willingness to sacrifice for the individual. But if this result turns out to be general, it suggests that compassion is an index of a stranger's level of need, not their value as a cooperative partner.

Also contrary to the alternative, "forgetting" hypothesis, the compassion means from this study (4.22 and 4.31) bracket Study 2's mean level of compassion in the high need conditions (4.27)—recall that in Study 2 participants rated their compassion after learning about the stranger's need but before learning about their sacrifice. Indeed, the total spread of these means is only 0.09 scale points on a 7-point scale, and a one-way ANCOVA among the three groups reveals no differences ($F(2,163) = 0.06$, $p = .94$; partial $\eta^2 = 0.0007$; controlling for baseline welfare tradeoff ratios). The fact that the need-tracking compassion reported subsequent to observing a needy, high sacrifice stranger is about as high as the compassion reported in the other two comparison classes strongly suggests that, contrary to the forgetting hypothesis, receiving high sacrifices from a stranger does *not* cause participants to forget that the stranger is in high need. Had the forgetting hypothesis

been correct, forgetting would have caused a drop in compassion in Study 3, when compared to the high need conditions of Study 2.

Further, there was no relationship between individual-level variation in compassion and participants' willingness to sacrifice for the stranger; neither among participants paired with strangers revealing high willingness to sacrifice, nor among participants paired with strangers revealing no willingness to sacrifice (partial $rs = 0.11$ and 0.02, $ps \geq 0.52$, controlling for participants' baseline willingness to sacrifice).

Note that here, too, subjects were somewhat *less* willing to sacrifice for a high need stranger when it was revealed that the needy stranger was *un*willing to sacrifice for the subject (Study 3, second sacrifice measure; M = 0.43, SD = 0.44) than when information was simply unavailable regarding the high need stranger's willingness to sacrifice for the subject (Study 1; M = 0.60, SD = 0.52; $t_{117} = -1.93$, $p = .056$, $r = 0.18$).

5. General discussion

Here we tested predictions derived from the hypothesis that helping can be generated by psychological mechanisms that see the need of another person as an opportunity to establish a mutually beneficial relationship with that person. The fitness benefits an individual derives from a given resource or act of help increases with the need of that individual—the same loaf of bread is more valuable to a starving than a sated person. Thus, from the perspective of a potential donor, helping the needy is a cost-effective way to enhance the needy person's welfare, and therefore a propitious opportunity to start a relationship through demonstrated goodwill.

Other variables surely interact with recipient need in the computation of a decision to deliver help—for example, helping needy kin also yields gains in inclusive fitness. Decisions about kin involve additional regulatory mechanisms dedicated to detecting and helping kin (Lieberman et al., 2007). For this reason, we tested need-based helping with respect to a stranger: A target individual genetically unrelated to and with no pre-existing relationship with the participants.

Social decision-making—including decisions about how much to sacrifice for another person—should be determined by more than one variable (well-known examples include kinship, formidability, reciprocation, the size of the resource to be divided, and differences between individuals in the marginal utility derived from a unit of the resource). The evolved mechanisms that generate these decisions should be designed to integrate the relevant variables in ways that promoted fitness ancestrally. In the present research, we hypothesized that cues diagnostic of a potential partner's high value as an associate, and of the long-run profitability of a relationship with them, will be weighted more heavily than the recipient's need in decisions to sacrifice for them (cf. Ackerman & Kenrick, 2008). Here we tested one such cue to association value: The recipient's willingness to sacrifice for the participant.

High willingness to sacrifice indicates that a stranger is likely to be a valuable long-term cooperative partner because she values your welfare—the sacrifice demonstrates her willingness to incur costs to provide benefits to you. If the adaptive function of the system that generates decisions to help strangers is to attract good cooperative partners, it should upregulate your own willingness to provide help in response to evidence that the stranger is willing to sacrifice to help you.

When they were asked to interact with a stranger, the participants' willingness to sacrifice for the stranger was regulated by the stranger's need and the stranger's willingness to sacrifice his or her own welfare to benefit the participant. But the effect of these two cues was not additive. The pattern of cue use across studies suggests that the motivational system activated in this situation integrates cues of cooperative partner value using a non-compensatory algorithm (e.g., the “take the best” algorithm; Gigerenzer & Goldstein, 1996).

In Study 1, the stranger's need level was the only information available to participants for deciding how much to sacrifice to benefit the stranger. In this situation, need is the best cue because it is the only cue. In the absence of willingness cues, participants in Study 1 sacrificed more for a needy stranger than for a happy, healthy stranger—as expected if motivations to initiate a new relationship are upregulated in situations where the benefit delivered to a stranger will be disproportionately helpful. Study 1 also showed that the amount of compassion participants felt for the stranger statistically mediated the relationship between the stranger's need level and participants' willingness to sacrifice to benefit that stranger.

In Study 2, we gave participants access to both cues: the stranger's need level and her willingness to sacrifice to deliver benefits to the participant. When the stranger's willingness to sacrifice for the participant was high, participants strongly upregulated their own willingness to sacrifice to provide benefits to the stranger. This was true whether the stranger was needy or not: Low need did not elicit extra sacrifice by the participant. This makes functional sense: A stranger who is willing to sacrifice for your benefit is likely to be a good potential long-term partner, whether that stranger is needy or not.

High willingness to sacrifice to benefit you is a strong cue that the stranger is likely to be a good long-term cooperative partner. When this strong cue was absent—that is, when there was evidence that the stranger was unwilling to sacrifice to help the participant—participants responded to the need cue. Happy, healthy strangers—ones whose need level is low—can afford to sacrifice to help you. When their choices demonstrate that they are unwilling to do so, that provides positive evidence that they do not value your welfare. As expected, this behavioral profile elicited very little sacrifice from participants: it implies that the stranger would be a poor long-term cooperative partner.

The inference that an unwilling stranger would be a bad long-term partner is less certain, however, when the stranger is suffering. When someone is in high need, they are more likely to lack the resources, time, or energy to provide aid to others. This does not necessarily mean they will make a poor social partner. Their unwillingness to sacrifice could result from desperate need, rather than a lack of concern for your welfare. It is possible that they would be good cooperative partners if their circumstances were better. Indeed, by helping them in their time of need, they can perhaps be returned to a position to help others, and a relationship with their benefactor can be initiated or strengthened. This logic implies that participants will be more willing to sacrifice to help an unwilling stranger when the stranger's need is high rather than low. That is what we observed.

Note, however, that participants sacrificed even more for strangers with a proven record of valuing their welfare than they did for strangers with the ambiguous behavioral profile of high need paired with low willingness to sacrifice. Motivations to incur costs to help a stranger were highest in response to strangers who had demonstrated their willingness to incur costs to help the participant, whether these willing strangers were needy or not.

It is too soon to know whether high willingness to sacrifice prevails over the use of need cues in all circumstances. On the one hand, a stranger's willingness to sacrifice even when needy may be a very reliable cue that the stranger values your welfare. But if high need reflects a situation that impairs the needy person's ability to provide you with help over the long run, a stranger who is healthy and prosperous might make a better long-term cooperative partner than one who is needy. Although the difference is not significant, the data hints at this second possibility: qualitatively, participants upregulated their willingness to sacrifice slightly more in response to the willing stranger who was healthier and happier than to the willing stranger who was suffering from the consequences of a previous misfortune.

Different research designs are necessary to tell whether cues of need, willingness to sacrifice, and ability to provide benefits sometimes interact to produce more subtle inferences about the probability that a stranger will make a good long-term cooperative partner. But the data so far suggest that the computational system evaluating the cooperative

potential of strangers integrates need and willingness cues using a non-compensatory algorithm, like the "take the best" rule, rather than an additive algorithm. A rule that is "fast and frugal"—that generates decisions based on limited information—makes sense for strangers. Having never met the person before, evidence of their value as a potential cooperative partner is necessarily limited.

5.1. Limitations of the studies

To provide better measures of people's willingness to sacrifice for others, the welfare tradeoff instrument we used de-confounds the cost required of the actor from the benefit delivered to the target. Such measures are reliable and externally valid (Delton & Krasnow, 2017; Delton & Robertson, 2016; Kirkpatrick et al., 2015; Krasnow et al., 2016). But in these studies, which experimentally manipulated the stranger's willingness to sacrifice and need level, this measurement instrument may confound other determinants of helping decisions. Helping decisions should be regulated, in part, by variables that reflect the extent to which one values the welfare of another individual (see below). But they should also be regulated by the marginal benefit of a resource to oneself and the other person. Marginal benefits will vary with need. It would be helpful to develop an instrument or experimental design that can clearly separate the effect of need on willingness to sacrifice from the effect of need on differences in the marginal benefit of a resource to self and other.

Also, our measure of sacrifice featured relatively low stakes. However, stakes of different size are known to influence helping decisions in different, subtle ways (Andreoni & Miller, 2002; Burnstein, Crandall, & Kitayama, 1994). Studies with different stakes and currencies would be illuminating.

Because these studies used only one experimental manipulation of need, the generalizability of the results across situations remains an open question. Future studies could investigate how the mind integrates information about a recipient's need with information relevant to other determinants of helping decisions (e.g., kinship, formidability); how helping decisions are made when sacrifices involve different currencies (e.g., donor's time against recipient's health); and the extent to which helping strangers in need reflects an evolved strategy for establishing long-term cooperative relationships with them (as suggested herein) versus strategies with other evolved functions.

Regarding other evolved strategies, we note that helping a stranger in need may indicate to third parties that the actor is willing and able to help others, including the third parties themselves. That inference may induce third parties to bestow benefits on the helper, creating a system in which the benefits of indirect reciprocity shape motivations to help strangers (Nowak & Sigmund, 2005). Partner choice in a biological market can also select for a psychology that helps strangers, if helping strangers signals one's cooperative value to third parties, who might choose the helper as a cooperative partner (Barclay, 2004, 2016). The present studies cannot test between these different hypotheses, although we note that a psychology shaped by indirect reciprocity is not mutually inconsistent with a helping psychology designed to establish relationships with the targets of one's help or with third parties observing the help. Those psychologies can be empirically distinguished based on their respective functional signatures, however (see Krasnow et al., 2016). Finally, although much work suggests that compassion functions to direct assistance to valued (or potentially valuable) people in need (Batson et al., 1983; Goetz et al., 2010), our finding that compassion may not translate into assistance suggests that this emotion has additional functions. Further work needs to be done to identify the latter.

5.2. Motivation and emotion

This research adds to the literature on the role *internal regulatory variables* play in computational systems that generate motivations and emotions (Delton & Robertson, 2016; Tooby, Cosmides, Sell, Lieberman, & Sznycer, 2008). Internal regulatory variables are quantitative variables that encode features of the self, others, and situation, and are used for decision making.

A computational system designed to make welfare tradeoffs uses variables of this kind. When asked to make decisions about how much to sacrifice to provide benefits to another person, the tradeoffs people make vary systematically with features of the situation, such as price and income (Andreoni & Miller, 2002), and they depend on which specific individual the person is helping (the particular sibling, friend, acquaintance, or stranger, for example; Hackman et al., 2015). The regularity and internal consistency of these decisions suggest that the mind has welfare tradeoff variables, which are transformed into parameters with a specific magnitude for specific individuals. In this view, the mind uses information such as kinship, formidability, value as a cooperative partner, productivity as a forager, reproductive value (and so forth) to compute welfare tradeoff parameters for each actor in one's social world. These parameters serve as input to cognitive functions that evolved to regulate how much personal welfare an individual is willing to trade off to enhance the welfare of another, specific individual in their social world.

The current studies connect the idea of internal regulatory variables, such as welfare tradeoff parameters, to compassion, an emotion that motivates the rendering of aid to needy others (Batson et al., 1983; Goetz et al., 2010). We speculate that one function of compassion is to temporarily increase the magnitude of a welfare tradeoff parameter used to regulate decisions about the needy person—at least when one lacks other information about that person's value as a potential cooperative partner. This cannot be the whole story, however: The fact that compassion can be elevated without a corresponding increase in one's willingness to sacrifice for another (Studies 2 and 3) suggests that compassion is not limited to increasing the motivation to deliver aid, and probably includes other effects—for example, updating estimates of the value that a needy person will attach to a resource (see also Stellar, Cohen, Oveis, & Keltner, 2015).

The results reported help to locate compassion within a functionally interlinked architecture of social emotions that also includes guilt, shame, pride, anger, and gratitude. Although each of these emotions has different hypothesized evolved functions, they all depend on an underlying cognitive architecture for trading off personal welfare against the welfare of specific others (Delton & Robertson, 2012; Sznycer, under review; Sznycer, Cosmides, & Tooby, 2017; Tooby et al., 2008). Briefly, under the welfare-tradeoff framework (Cosmides & Tooby, 2000; Tooby et al., 2008), the function of guilt is to prevent or remedy events where one put too low a weight on the welfare of a valued other (often unintentionally), independent of whether the other will know it (Baumeister, Stillwell, & Heatherton, 1994). The function of shame is to limit information-triggered reductions in the weight placed on one's welfare by others (Robertson, Sznycer, Delton, Tooby, & Cosmides, 2018; Sznycer et al., 2012; Sznycer, Schniter, Tooby, & Cosmides, 2015; Sznycer, Tooby, et al., 2016; Sznycer, Xygalatas, Agey, et al., under review). The function of pride is to motivate the individual to achieve and advertise traits or acts that cause others to place a higher weight on his or her welfare (Sznycer et al., 2017; Sznycer, Xygalatas, Alami, et al., under review; Tracy, Shariff, & Cheng, 2010). The function of anger is to incentivize others to place a higher weight on one's welfare when that weight is deemed insufficient (Sell, 2011; Sell et al., 2017, 2009). The function of gratitude is to consolidate a higher level of cooperation with individuals whose actions reveal that they value one's welfare more highly than expected (Lim, 2012; Smith et al., 2017). And the function of compassion, as suggested above, is to enhance the welfare of a needy other, either because their welfare is inherently valuable to the individual (Tooby & Cosmides, 1996), or as a cost-effective overture to a mutually-beneficial relationship.

Using theories of selection pressures, evolutionary psychologists have mapped an array of psychological systems that use computational

variables to regulate social behavior: Psychologies for kin altruism (Lieberman, 2009; Lieberman et al., 2007), for dyadic reciprocity (Cosmides, Barrett, & Tooby, 2010; Cosmides & Tooby, 1992, 2005), for risk-pooling (Delton et al., in press; Delton & Robertson, 2012; Kameda et al., 2002; Sznycer et al., 2017), for reputation and partner choice (Barclay, 2016; Krasnow, Cosmides, Pedersen, & Tooby, 2012), and so forth. How these various psychologies interact—when and how they use different regulatory variables so that the resulting decision is computed in ways that would have promoted fitness ancestrally—-constitutes an independent adaptive problem that would have selected for its own array of functionally specialized adaptations (Tooby et al., 2008). The interaction between the variables studied here constitutes a small sample of the mapping that remains to be done.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.evolhumbehav.2018.07.005.

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