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Cognitive foundations for helping and harming others: Making welfare tradeoffs in industrialized and small-scale societies

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ABSTRACT

For many abilities, such as vision or language, our conscious experience is one of simplicity: We open our eyes and the world appears; we open our mouths and grammatical sentences tumble out. Yet these abilities rely on immensely complex, unconscious computations. Is this also true of abilities related to cooperation or competition, like deciding whether to share food or spread gossip? We tested whether decisions like these are guided by precise psychological variables, called *welfare tradeoff ratios*. Welfare tradeoff ratios summarize information about multiple sources of social value (such as whether a specific other person is kin or is generous with the self) along with information about the situation (such as what's at stake or who else is watching). We evaluated these hypothesized variables in four societies: among college students in the USA and Argentina and among two groups of Amazonian forager-horticulturalists, the Shuar of Ecuador and the Tsimane of Bolivia (*ns* = 167, 131, 73, 23). In all societies people made a series of hypothetical decisions where they had to weigh help or harm for themselves versus others. We found strong evidence that people trade off their welfare for others with consistency—a signature of decisions being guided by precise variables in the mind. We also found evidence in three of the societies that people discriminate among different categories of others in their welfare tradeoffs (e.g., friends versus acquaintances). Although most decisions about helping or harming feel simple and intuitive, they appear to be underwritten by precise computations.

1. Introduction

Open your eyes and the world floods in. With no conscious effort, you are greeted by scenes of people and animals, colors and textures, emotions and gestures, beauty and ugliness. Yet vision is anything but simple (Land & Nilsson, 2002; Marr, 1982). The eye and visual system evolved to create a three-dimensional representation of the world using the two-dimensional pattern of photons hitting our retinas. This requires computations so complex that they are still not entirely understood. Conscious simplicity hides computational complexity.

Vision, of course, is not the only problem humans evolved to solve. As a social species, we cooperate and compete, and as such *we often make decisions that affect the welfare of ourselves and others*. Should you share food with a sibling? Watch a friend's child? Spread gossip about a rival? A particular choice could cost you. Food given away is food not eaten. Time babysitting is time not spent elsewhere. Rumor-mongering invites retaliation. Here we tested whether decisions that simultaneously impact the welfare of ourselves and others—decisions that could help or harm—are also underwritten by a series of complex, largely unconscious computations. Just as with vision, our conscious experience

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of cooperating and competing might appear simple ("Obviously I'll help") yet be enabled by complex computations.

Specifically, we tested the hypothesis that when the mind decides whether to help or harm, it uses precise variables to guide its decisions. These proposed variables have been called *welfare tradeoff ratios* (e.g., Cosmides & Tooby, 2013; Delton & Robertson, 2016; Tooby, Cosmides, Sell, Lieberman, & Sznycer, 2008). If this hypothesis is correct, results should reveal that people make decisions about helping and harming with *consistency*. Without a precise variable that guides decisions, consistency would be difficult to accomplish.

We tested our hypothesis in four samples. To begin, we collected data from college students in the US and in Argentina. Consistency, if observed among college students, would be in line with the hypothesis that precise variables underpin welfare tradeoffs. But college students come from evolutionarily novel backgrounds: educated, industrialized societies with complex, democratic governments (Henrich, Heine, & Norenzayan, 2010). So, consistency in students' decisions could also be attributed to their formal schooling, their experience with money, their orientation to think analytically, or a host of other reasons besides the operation of a universal psychology for helping and harming. But if we also find consistency among people with less schooling or integration with markets, we can be more confident that the consistency is due to species-typical psychology: welfare tradeoff ratios. Thus, we also collected data from community samples of forager-horticulturists from the Shuar of the Ecuadorian Amazon and the Tsimane of the Bolivian Amazon.

In the General Discussion, we compare our data and interpretation with three other possibilities: simple heuristics, focal points, and social preferences. These alternative hypotheses would generally predict distributions of choices, concentrated on particular values, that are different from the distributions we found. We also discuss the possible role of welfare tradeoff ratios in emotions, reciprocity, and reputation.

1.1. How the mind might decide whether to help or harm

Let's see why a variable like a welfare tradeoff ratio might exist in the mind. To do this, we'll look at one hypothesis about how our minds decide whether to help or harm. On this hypothesis, helping or harming requires interlocking sets of computations (e.g., Cosmides & Tooby, 2013; Delton & Robertson, 2016; Tooby et al., 2008). One set of computations solves the problem of assessing which other people are valuable to the self and which are harmful. Valuable associates might be worth helping, and harmful associates worth harming in turn. This problem fractions into many subsidiary problems because there are many ways a person can be valuable or harmful. Someone can be valuable if they are kin, if they are generous, or if they are skillful. Someone can be harmful if they are competing with you for status or for mates. Thus, the mind must assess the value of others along many dimensions.

The mind appears to perform such computations. Some of these allow us to detect genetic siblings (Lieberman, 2009; Lieberman & Lobel, 2012; Lieberman, Tooby, & Cosmides, 2003, 2007; Sznycer, De Smet, Billingsley, & Lieberman, 2016). These computations bring together multiple cues to sibship, including how long one has lived with a potential sibling and whether one observed a potential sibling being intensely cared for by one's own mother. Other computations estimate a person's formidability—their ability to prevail in conflict—by combining information about body size, physical strength, and allies (Delton & Sell, 2014; Pietraszewski & Shaw, 2015; Sell et al., 2009; Sell et al., 2010; von Rueden, Gurven, & Kaplan, 2008). Still other computations estimate a person's value as a cooperation partner, combining information such as whether the person is willing to cheat and how long the relationship will last (Balliet, Tybur, & Van Lange, 2017; Barclay, 2013; Cosmides & Tooby, 1992, 2015; Delton & Sell, 2014).

Assessing people along multiple dimensions creates another problem, however: This information must be integrated. You cannot simultaneously help a person because he is your brother and not help him because he is stingy. Thus, the mind also needs computations that integrate different types of value so that you can, right now, make a decision. Similarly, your mind must also incorporate information like who is watching or what is at stake. You might be more likely to help your brother if your parents can see you or if his life is on the line. Stakes, audiences, and other features of a situation matter (Curry, Roberts, & Dunbar, 2013; Hackman, Danvers, & Hruschka, 2015; Ostaszewski & Osiński, 2011; Rachlin & Jones, 2008b; Stewart-Williams, 2007; Xue, 2013).

This is why we hypothesize that the mind contains a summary variable indexing the value of a specific other person's welfare relative to the welfare of the self: Summary variables integrate information computed upstream. We call these summary variables *welfare tradeoff ratios* because they determine how people trade off their own welfare to improve or damage the welfare of others. By hypothesis, the mind computes a unique welfare tradeoff ratio *for a particular person, at a particular moment in time*. The mind uses this variable to decide whether to cooperate or compete.

1.2. Testing for welfare tradeoff ratios

Does the mind compute welfare tradeoff ratios? We answer this question by assessing whether people can trade off their own welfare against someone else's with *consistency*. If the mind computes precise variables for helping and harming—welfare tradeoff ratios—then people should be very consistent when making decisions involving tradeoffs between the welfare of themselves and others.

We evaluated this prediction using a simple method. We gave people a series of decisions where they had to choose whether to take money for themselves *or* pass up this money and allow a specific other person (e.g., a friend, acquaintance, or sibling) to get a different sum of money. (Study 4 used food instead of money.) We then quantified how consistently people made these decisions.

1.2.1. Measuring consistency

It's easiest to understand with specifics, so we will illustrate with the exact method used with US and Argentine college students in Studies 1 and 2. Thus, this section and the next also serve as the primary methods sections for those two studies.

Each student made 60 decisions regarding their closest, same-sex friend and the same 60 decisions regarding a same-sex acquaintance. The 60 decisions were separated into 6 series, each with 10 decisions; see Table 1. Within each series, we held constant the amount at stake for the friend or acquaintance but varied the amount at stake for the student. We'll use as a running example the third series shown in Table 1. In this series a student is asked, for example, Do you want to keep $34 for yourself *or* allow a friend to have $75? $49 for you or $75 for your friend? $64 for you or $75 for your friend? $79 for you or $75 for your friend?

We quantified consistency in two ways. First, *perfect consistency* requires that a student always *keeps for themselves* when the amount they would get is *above* a certain point and always *gives to the other person* when the amount the student would get is *below* a certain point. For instance, a perfectly consistent response in our example would be to always keep for the self when you would receive $49 or more (the top five decisions) and to always give to the other when you would receive $34 or less (the bottom five decisions). Thus, in this example, your *switchpoint* is between $49 and $34.

A perfectly consistent series of 10 decisions has at most a single switchpoint. Either people switch just once, as in this example, or they do not switch at all, either always giving or always keeping. For simplicity in our exposition, we will call always giving or always keeping switchpoints even though the person does not actually switch. Note, however, that never switching might also reveal a lack of understand-

Table 1
Amounts of money at stake and possible welfare tradeoff ratios (WTRs) for students in the US and Argentina.

US & Argentina Studies 1 & 2												
Amounts at Stake												
Self	Other	Self	Other	Self	Other	Self	Other	Self	Other	Self	Other	Possible WTRs
54	37	33	23	109	75	28	19	67	46	99	68	1.55
46	37	29	23	94	75	24	19	58	46	85	68	1.35
39	37	24	23	79	75	20	19	48	46	71	68	1.15
31	37	20	23	64	75	16	19	39	46	58	68	0.95
24	37	15	23	49	75	12	19	30	46	44	68	0.75
17	37	10	23	34	75	9	19	21	46	31	68	0.55
9	37	6	23	19	75	5	19	12	46	17	68	0.35
2	37	1	23	4	75	1	19	2	46	3	68	0.15
−6	37	−3	23	−11	75	−3	19	−7	46	−10	68	−0.05
−13	37	−8	23	−26	−75	−7	19	−16	46	−24	68	−0.25
												−0.45

Note. For the ordered version, participants completed the series in the order shown, going left to right; the first, fourth, and sixth series were completed in the order shown, top to bottom; the second, third, and fifth series were completed in the opposite order, bottom to top. Amounts were indicated in US dollars in the US and in Argentine pesos in Argentina. There is necessarily one more possible welfare tradeoff ratio than decisions within a set. Each possible WTR represents the WTR that would be assigned if a participant was perfectly consistent and switched between keeping to giving in the decisions in the same row and the row above each possible WTR. The exceptions are that the top and bottom possible WTRs correspond to never switching. See Fig. 1 for more explanation.

ing or attention; we therefore present all our main results with and without participants who never switched.

In sum, perfect consistency measures whether a person did (vs. did not) have a single switchpoint within a series of decisions. (To be conservative, if a person leaves a choice blank, the entire series is scored as inconsistent.) We computed 12 separate perfect consistency scores, one each for the 6 series for the friend and similarly for the acquaintance. We then computed an average for the friend and an average for the acquaintance. If a person was deciding randomly, there is a 1.1% chance of being perfectly consistent in a series. (There are 11 possible ways of being perfectly consistent in a series. There are 2^{10} possible ways to fill out a series. $11 / 2^{10} = 1.1\%$.)

A complication arises: What happens if people switch more than once? For instance, a person might pass up $49, keep $64, but then pass up $79. Even if a precise variable is guiding choices, people might still be slightly inconsistent due to inattention or misunderstanding. Therefore, we also computed a second, less stringent measure that we call *consistency maximization*. To do so, we borrowed a method developed to study other types of tradeoff decisions (Kirby & Marakovic, 1996). This method considers every possible switchpoint. For each one, it counts the number of actual choices that are consistent with that switchpoint. The switchpoint with the highest count wins. The percentage of choices consistent with that best switchpoint is the consistency maximization score. Although there are more complicated methods with similar goals (e.g., Andreoni & Miller, 2002; Vincent, 2016), our method has the virtue of simplicity and ease of replication. (There can be ties but tied switchpoints necessarily have identical consistency maximization scores.)

In sum, consistency maximization measures the percent of choices that are consistent with the best fitting switchpoint. Again, we computed 12 separate scores, 6 for friends and 6 for acquaintances, and then an average for the friend and an average for the acquaintance. If a person was responding at random to the 10 decisions in a series, the expected consistency maximization score would be 71%. (We computed this by generating all possible series of 10 choices, determining for each the number of scores consistent with the best fitting switchpoint, and then averaging these together.)

1.2.2. Creating a quantitative estimate of welfare tradeoff ratios

Although we are mostly interested in testing for consistency, we also tested whether people revealed different welfare tradeoff ratios for different categories of people. Compared to acquaintances, we expected people to have higher welfare tradeoff ratios for friends (and family in later studies) given the fitness interests entailed in such relationships (Hamilton, 1964; Hruschka, 2010; Trivers, 1971). This seems especially likely to be true in our samples of students where acquaintances are likely to be fairly distant compared to friends. When we turn later to small-scale societies, this prediction is less obvious. Even acquaintances are likely to be reasonably well-known and there could be strategic reasons to share with them.

How should welfare tradeoff ratios be estimated? The theory we reviewed above hypothesizes a series of computations that appraise people on multiple dimensions of value (e.g., kinship, formidability) and then integrate these (along with information like what's at stake and who's watching) to arrive at a summary variable, the welfare tradeoff ratio.

To our knowledge, the exact form of these computations is not known yet. For instance, it's unknown how, quantitatively, information on kinship is weighed against information on generosity. Thus, to derive quantitative estimates of welfare tradeoff ratios, we made many simplifying assumptions, which are described in the online supplement.

Based on these simplifications, we assume that participants will sacrifice for the other person when their welfare tradeoff ratio (WTR) satisfies the following inequality:

$$\text{WTR} > \text{Amount for Self} / \text{Amount for Other} \quad (1)$$

The larger a participant's WTR, the more willing they are to sacrifice. Given that the amount for the other is held constant, this means that participants reveal larger WTRs by passing up ever larger amounts for themselves. A negative WTR means that a participant is willing to spite the other person (Del Ponte, Delton, & DeScioli, 2021). This inequality also shows why we call the variable a welfare tradeoff *ratio*: In the simple form used here, decisions depend on the ratio between one's own welfare and the welfare of the other person.[2]

Here's how we use this simple inequality to estimate participants' welfare tradeoff ratios, as summarized in Fig. 1 (using the third series from Table 1). Consider the first choice: $109 for the self versus $75 for the other person. The ratio of these amounts is roughly 1.45. So, if a

[2] This functional form was inspired by classic theories of social evolution, such as kin selection theory, reciprocity theory, and theories of conflict (Axelrod & Hamilton, 1981; Hamilton, 1964; Hammerstein & Parker, 1982; Trivers, 1971). For more discussion, see the online supplement.

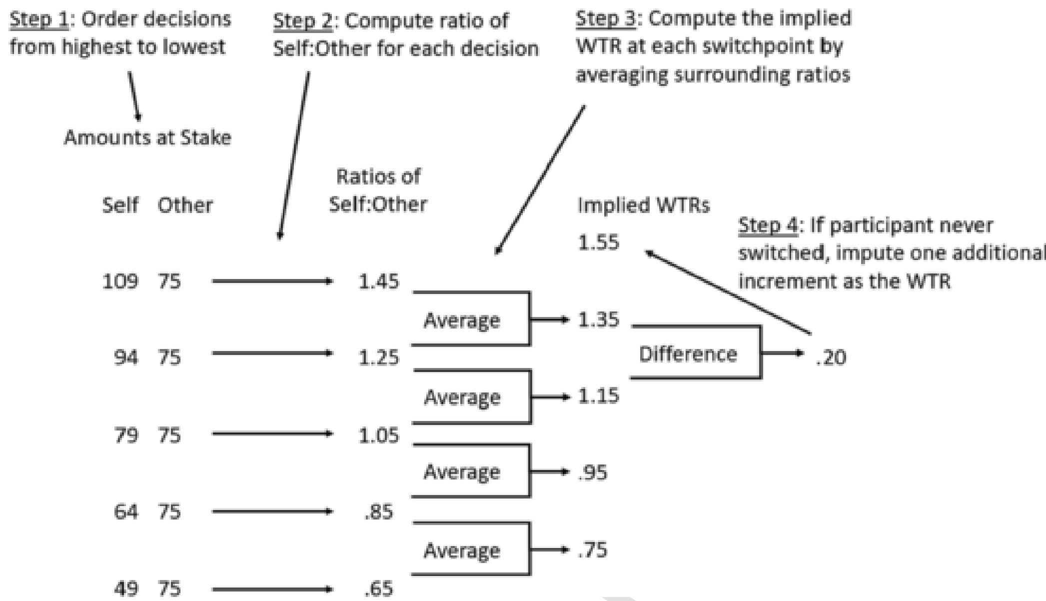

Fig. 1. Illustration of how we, the researchers, inferred participants' welfare tradeoff ratios (WTRs) from their decisions.

participant chose to *keep for themselves*, then their welfare tradeoff ratio for the other person must be less than 1.45.

Now consider the second decision in the table, \$94 versus \$75. The ratio here is roughly 1.25. So, if the same participant chose to *give to the other person*, then their welfare tradeoff ratio for the other person must be more than 1.25.

Assuming this participant also gives to the other person when the amount for the self is even lower than \$94, their actual WTR must lie somewhere between 1.25 and 1.45. For simplicity we assign the arithmetic average, 1.35. The final column of Table 1 shows the possible welfare tradeoff ratios that could be assigned using our method.

What if a participant always keeps or always gives to the other person? Strictly, their ratio in these cases cannot be known with certainty; the estimate is unbounded. But for simplicity, we assume that the ratio for such cases follows the pattern of the ratios that preceded it. This scoring choice can be seen in the first and last ratios listed in Table 1. As mentioned before, we also ran all main analyses removing such participants who never switched.

If a participant was perfectly consistent, calculating their welfare tradeoff ratio is straightforward. If not, we collected all the switchpoints that tied for best fitting (under the consistency maximization procedure) and averaged together the welfare tradeoff ratios associated with them.

For each student, we computed 12 welfare tradeoff ratios, one each for the 6 sets of decisions toward friends and for the 6 toward acquaintances. We then averaged the 6 ratios for the friend and, separately, the 6 for the acquaintance to arrive at final estimates of our students' welfare tradeoff ratios. Although each set of decisions used different dollar amounts, we designed them to all reveal the same ratios.

2. Studies 1 and 2: College students in the United States and Argentina

In our initial test, college students responded to hypothetical choices where they could give money to themselves or give money to a specific person they know. Although these choices were hypothetical, research on other US samples finds that people make these decisions similarly when real money is at stake (Del Ponte et al., 2021; Delton, 2010). All students made decisions about two other people: their closest same-sex friend and a same-sex acquaintance.

In these samples, we randomly assigned some students to make their decisions in *order*: All decisions in a series were grouped together and ordered, either high to low or low to high. The other students received the decisions *scrambled*: All decisions were randomly mixed. If there is a precise variable in the mind, the manipulation of ordered versus scrambled should have little effect on students' consistency. If consistency is an artifact of seeing decisions in order, however, then consistency should drop considerably in the scrambled version.

2.1. Methods

2.1.1. Participants and procedure

For Study 1 in the United States, 167 students (90 female; average age = 20 years) at the University of California, Santa Barbara, participated. For Study 2 in Argentina, 131 students (78 female; 6 missing data on sex; average age = 21 years) from the University of Buenos Aires participated. In the US, students completed the study in small groups in our lab. In Argentina, students completed the study in large groups in a lecture hall. Both samples filled out surveys on paper. The materials were identical except that they were translated into Spanish for the Argentine sample (by author DS) and the amounts were presented as pesos for this sample. The order of friend and acquaintance was counterbalanced. Participants picked real people they knew and wrote down their initials. All students gave informed consent before completing the survey.

2.1.2. The welfare tradeoff task

Example English materials are in the supplemental information. Table 1 displays the money at stake in each decision. In the *ordered* condition, students received 6 discrete sets of 10 decisions each (n = 82 in US; n = 67 in Argentina). Within a set the decisions were ordered either high to low or low to high. In the *scrambled* condition students received the 60 decisions in a random order (n = 85 in US; n = 64 in Argentina). Given the paper format, we used only one random order. Students were asked to imagine that only one decision would possibly be realized and so make each decision as if it was the only one they were making. This was to discourage the inference that a reciprocal strategy is possible (e.g., "I gave to myself last time, so I'll give to her now"). The task was scored using the procedure describe in Section 1.2.

All *p*-values are two-tailed. We analyzed the data using SPSS version 28. All data can be found at: https://osf.io/hk9y8/?view_only=dcedd73f88134d91b46569d95a343d72.

2.2. Results

2.2.1. Did students make consistent decisions?

As predicted, students were extremely consistent in their decisions. As shown in the top of Fig. 2, consistency maximization scores were very high, around 97% in the US and 94% in Argentina. Students were far more consistent than would be expected by chance (random responding = 71%; one-sample *t*-tests: all $ts > 30$, all $ps < 0.001$, $df_{US} = 166$, $df_{Argentina} = 130$, all Cohen's $ds > 2.6$).

Turning to perfect consistency, we again find that students were extremely consistent. As shown in the bottom of Fig. 2, perfect consistency scores were 83–88% in the US and about 69% in Argentina. Again, students were more consistent than would be expected by chance (random responding = 1.1%; all $ts > 22$, all $ps < 0.001$, $df_{US} = 166$, $df_{Argentina} = 130$, all Cohen's $ds > 1.9$).

Did students perform substantially worse when making decisions that were scrambled versus ordered? No. As Fig. 3 shows, students were nearly as consistent regardless of format. If seeing the decisions in order was the main source of students' consistency, performance should have plummeted for the scrambled format. But this didn't happen. In fact, in nearly every pair, there was no significant difference between the ordered and the scrambled versions ($ts < 1.24$, $ps > 0.20$, $df_{US} = 165$, $df_{Argentina} = 129$, Cohen's $ds < 0.2$). The lone exception was that the scrambled version was significantly less consistent for friends in Argentina when measured as perfect consistency ($t(129) = 2.35$, $p = .02$, Cohen's $d = 0.41$). Either way, for all scrambled versions, both types of consistency scores were much larger than chance (for consistency maximization: all $ts > 22$, all $ps < 0.001$, $df_{US} = 84$, $df_{Argentina} = 63$, all Cohen's $ds > 2.8$; for perfect consistency: all $ts > 15$, all $ps < 0.001$, all Cohen's $ds > 1.9$). Overall, students were about as consistent regardless of the order of the decisions.

The above results reveal striking consistency. But perhaps consistency was arbitrarily inflated by students who never switched, either always keeping or always giving. Maybe these students were not paying attention and just selected the same answer over and over to speed through the survey. We removed all such series and then recalculated both types of consistency scores. Even removing cases with no switching, students were still extremely consistent within a set of 10 decisions:

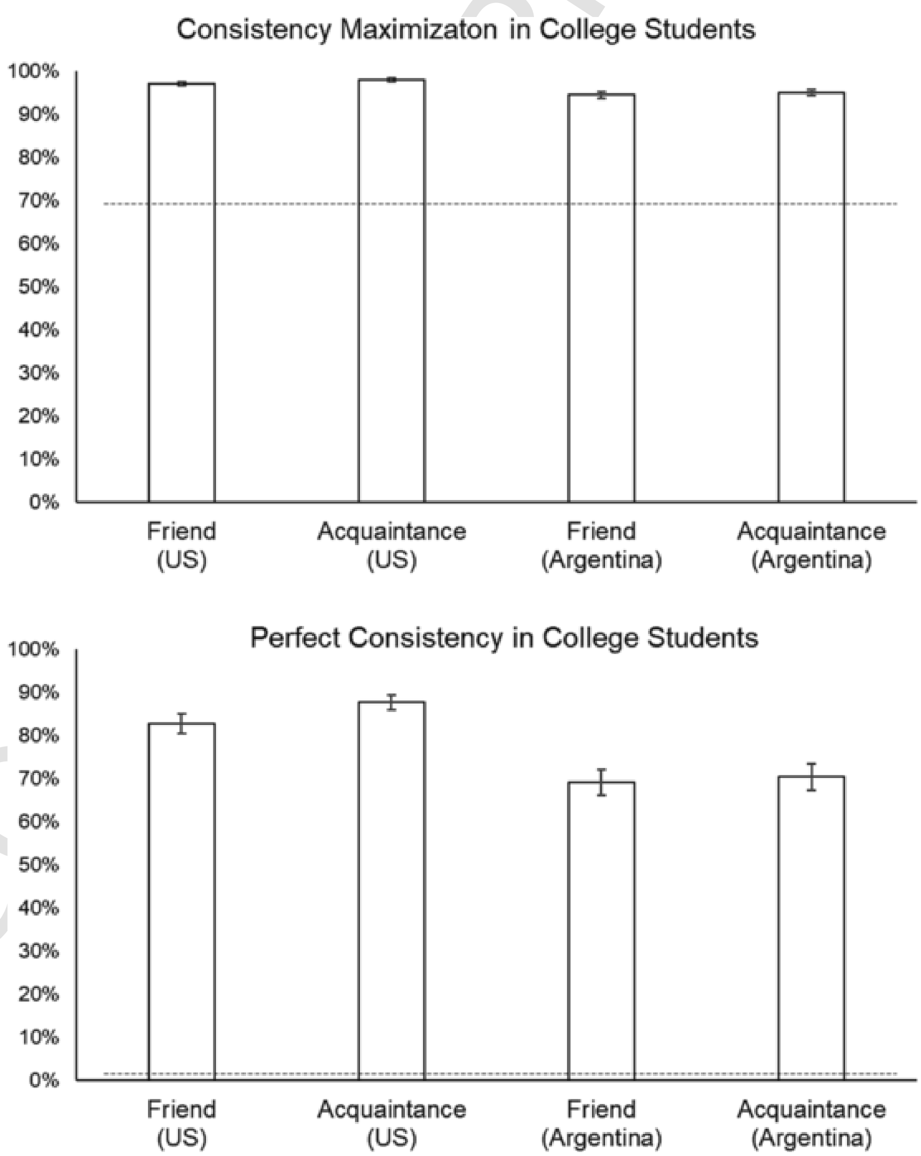

Fig. 2. Consistency Maximization (top panel) and Perfect Consistency (bottom panel) from the US and Argentina (Studies 1 and 2). The dashed lines represent random responding of 71% and 1.1%, respectively. Error bars are standard errors of the mean (SEMs).

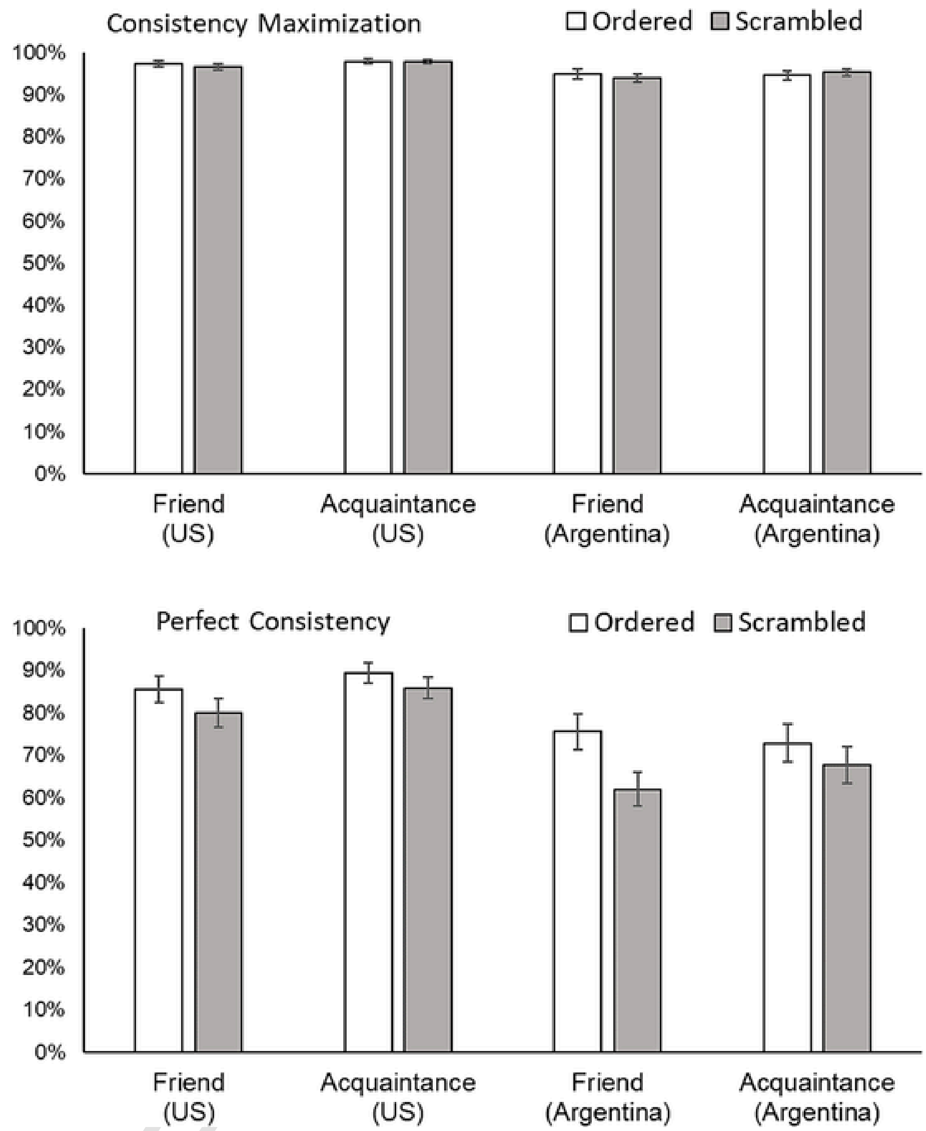

Fig. 3. Ordered versus Scrambled for Consistency Maximization (top panel) and Perfect Consistency (bottom panel) in the US and Argentina (Studies 1 and 2). Error bars are SEMs.

consistency maximization scores ranged from 93% to 98% for friends and from 93% to 98% for acquaintances; for perfect consistency, scores ranged between 62% and 86% for friends and between 65% and 89% for acquaintances. All of these were greater than random responding (all *ps* < 0.001).

2.2.2. Did students treat friends and acquaintances differently?

Fig. 4 graphs the distribution of welfare tradeoffs ratios that students had toward their friends and acquaintances. As shown in Fig. 5, students in both countries were more willing to trade off their own welfare to benefit a friend than an acquaintance, as revealed by larger ratios. In the US, students had average ratios of 0.62 for friends versus 0.34 for acquaintances (*SD*s = 0.35 and 0.36; paired-sample $t(166) = 12$, $p < .001$, Cohen's $d = 0.90$). A ratio of 0.62 implies that the decision-maker would be willing to pass up as much as $6.20 if they could give $10 to the other person. A ratio of 0.34 implies they would only pass up as much as $3.40 to give the same $10 to the other person. In Argentina, students had an average ratio of 0.75 for friends and 0.50 for acquaintances (*SD*s = 0.37 and 0.37; paired-sample $t(130) = 10$, $p < .001$, Cohen's $d = 0.88$).

We can also use students' welfare tradeoff ratios to test for another type of consistency. Recall that, for a particular target, students completed six series of decisions. Do the welfare tradeoff ratios revealed by these six series correlate with each other? Yes, they do in both countries and for both friends and acquaintances; the Cronbach's αs range from 0.89 to 0.95. On yet another measure, students were very consistent.

2.3. Discussion

College students in the US and Argentina both made extremely consistent decisions, whether measured by consistency maximization or by perfect consistency. They also revealed larger welfare tradeoff ratios for their friends than acquaintances. Still, despite coming from two different countries, these participants all hailed from industrialized, Western countries. Perhaps there is something idiosyncratic about students in these societies compared to people in other cultures. In our next two studies we turned to very different samples: community samples from forager-horticulturalists.

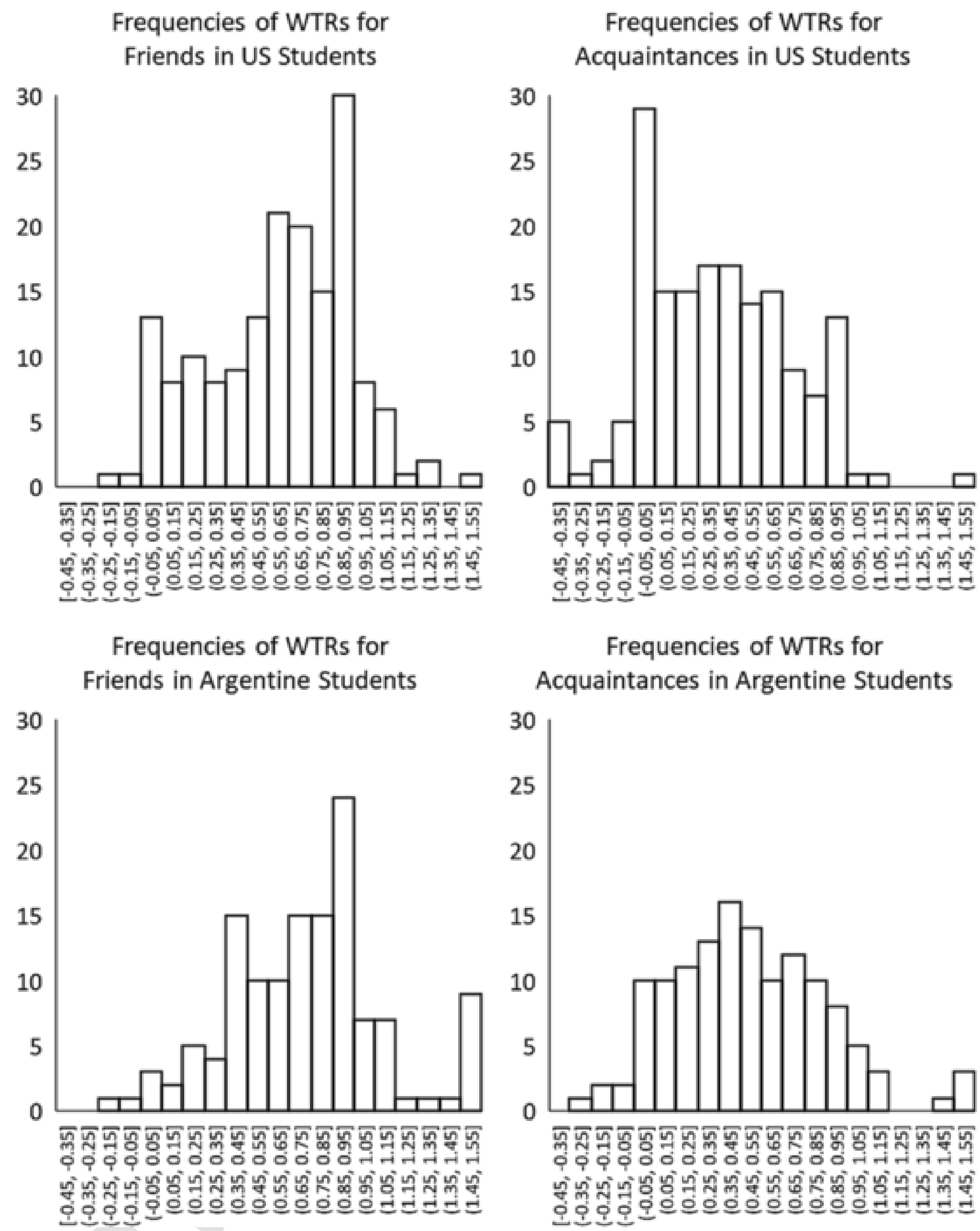

Fig. 4. Frequency Histograms of Welfare Tradeoff Ratios in the US and Argentina (Studies 1 & 2).

3. Study 3: Shuar forager-horticulturalists in the Ecuadorian Amazon

For Study 3 we recruited a community sample from Indigenous Shuar living in the Ecuadorian Amazon. The task still involved monetary tradeoffs between self and others (in US dollars, the official Ecuadorian currency). Because Shuar people have less formal schooling than college students, we asked them to make a single set of 15 decisions; see Table 2 for the amounts at stake and the possible welfare tradeoff ratios. Although this is fewer decisions overall, it is more difficult to achieve consistency with 15 decisions per set rather than 10 per set as used with students. The order was always scrambled. We asked participants to make the same set of decisions three times, once each for a specific friend, acquaintance, and sibling chosen from a set of photographs of individuals from their own and close neighboring communities. As before, to test for the existence of a precise variable guiding decisions, we conducted two types of tests. As our main test, we examined whether the Shuar made decisions consistently. We also tested whether the Shuar discriminated in their ratios among friends, acquaintances, and siblings.

3.1. Method

3.1.1. Participants

We collected data from 73 Shuar (51 female; average age = 34, range = 16–63, with 13 missing values for age). Author LSS conducted the interviews in Spanish, as the majority of Shuar people speak Spanish. He also received authorization and coordinated with communities to conduct the research. No one was individually compensated for participation. Compensation was provided as community goods (e.g., medical supplies) and was not contingent on any individual's participation. The study was conducted in October of 2010.

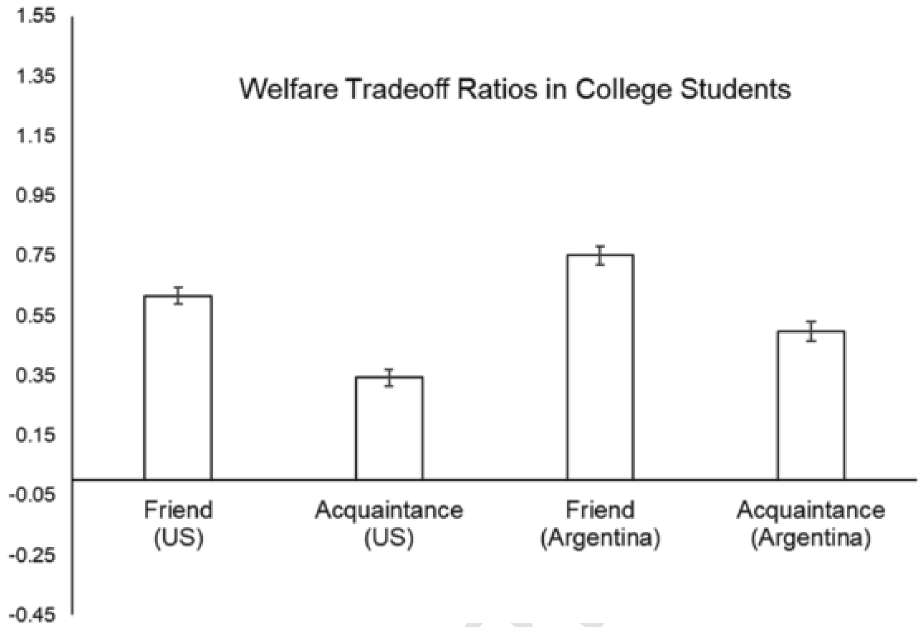

Fig. 5. Average Welfare Tradeoff Ratios of College Students in the US and Argentina (Studies 1 & 2). Bars indicate mean Welfare Tradeoff Ratios. Error bars are SEMs.

Table 2
Amounts of money at stake and possible welfare tradeoff ratios (WTRs) for community participants among the Shuar.

Shuar Study 3		
Amounts at Stake		
Self	Other	Possible WTRs
14.5	10	1.55
12.5	10	1.35
10.5	10	1.15
9.5	10	1
8.5	10	0.9
7.5	10	0.8
6.5	10	0.7
5.5	10	0.6
4.5	10	0.5
3.5	10	0.4
2.5	10	0.3
1.5	10	0.2
0.5	10	0.1
−1.5	10	−0.05
−3.5	10	−0.25
		−0.45

Note. Participants among the Shuar always made decisions in a random order. Amounts were in US dollars. There is necessarily one more possible welfare tradeoff ratio than decisions within a set. Each possible WTR represents the WTR that would be assigned if a participant was perfectly consistent and switched from keeping to giving in the decisions in the same row and the row above each possible WTR. The exceptions are that the top and bottom possible WTRs correspond to never switching. See Fig. 1 for more explanation.

3.1.2. *Ethnographic context*

The Shuar are an expanding, Indigenous population totaling more than 110,000 people living in southeastern Ecuador (Blackwell, Pryor III, Pozo, Tiwia, & Sugiyama, 2009; *Consejo de Desarrollo de las Nacionalidades y Pueblos del Ecuador*, 2012; Madimenos, Snodgrass, Liebert, Cepon, & Sugiyama, 2012). Prior to the middle of the 20th century, Shuar lived in dispersed independent households or matrilocal clusters, subsisting on swidden horticulture, hunting, fishing, and foraging. Warfare and feuding were endemic throughout Shuar history (Harner, 1984; Karsten, 1935; Stirling, 1938). Formation of communities, *centros*, began in the mid-20th century (Rubenstein, 2001). Today, communities typically contain 30 or fewer households, often spanning multiple generations, though some communities are much larger as population and land tenure limit mobility. Communities are relatively egalitarian such that, as with other groups (e.g., Chagnon, 1996), they often fission politically when disputes arise and kinship cannot hold communities together. Genetic relatedness within communities is relatively high compared to Western societies. For example, in one fairly large village, the average resident was genetically related to 47% of the other residents (Price, 2006).

Interviews were conducted in one primary and two adjacent communities which are about 35–45 minutes by truck from the nearest market town. Since the early 2000s, market integration has accelerated. Shuar in these communities augmented traditional subsistence practices with some agro-pastoralist production, sale of forest products, and sporadic wage labor. Traditional cultigens (e.g., manioc, plantains, sweet potatoes, and yams) remained the dietary staples, accounting for more than 65% of the diet, while fishing, hunting, and foraging were limited due to population pressure on these resources (e.g., Liebert et al., 2013; Urlacher et al., 2016). The households remains the primary unit of production, with limited food shared among a few closely related households. However, manioc beer (*nihamanch*) is shared with household visitors and at community events, and people sometimes hold work parties (*mingas*) to clear subsistence gardens, community spaces, or to fish the river with *barbasco* poison.

3.1.3. *The welfare tradeoff task*

The Shuar completed a single series of 15 decisions per target (Table 2). This allowed for 16 possible welfare tradeoff ratios. The decisions were hypothetical and were always scrambled. The Shuar completed three sets of decisions, one each for a friend, an acquaintance, and a sibling. Amounts were in US dollars (the currency used in Ecuador). According to World Bank estimates from 2010, the annual gross national income per capita of Ecuador was $4510—about $12 a day.

Scoring was the same as for the studies with college students. With 15 decisions per set (rather than 10), a person responding randomly would have an expected consistency maximization score of 68% and a 0.05% chance of achieving perfect consistency. Thus, the Shuar faced a more difficult consistency problem than the students.

3.2. Results

3.2.1. Did the Shuar make consistent decisions?

Shuar participants were very consistent. As shown in Fig. 6, consistency maximization ranged between 85% to 88%. This is greater than what would be expected by chance (= 68%, one-sample *t*-tests: all $t(72)$s > 10, all *ps* < 0.001, all Cohen's *ds* > 1.2).

Fig. 6 also shows that perfect consistency was high, 25% for friends and 41% for siblings and acquaintances. This is also greater than chance (= 0.05%, all $t(72)$s > 4.8, all *ps* < 0.001, all Cohen's *ds* > 0.56).

We re-ran the analyses when removing cases where a person never switched, either always giving or always keeping. Even removing cases with no switching, the Shuar were still extremely consistent: on consistency maximization, ~84% for all three categories; on perfect consistency, 15% for friends and ~22% for acquaintances and siblings. All of these were greater than random responding (all *ps* ≤ 0.001).

3.2.2. Did the Shuar treat friends, acquaintances, and siblings differently?

Fig. 7 shows the distribution of welfare tradeoff ratios revealed by the Shuar. As shown in Fig. 8, unlike the students, the Shuar did *not* reveal different ratios for friends, acquaintances, or siblings. All the ratios were about 0.45 (*SDs* ≈ 0.67) and none differed significantly (all paired samples $t(72)s < 1$, $ps > 0.37$, Cohen's $ds < 0.11$). A ratio of 0.45 implies that the average Shuar would pass up as much as \$4.50 to give \$10 to another person.

3.3. Discussion

Like the college students from the US and Argentina, the Shuar were very consistent in their choices—despite having more decisions to make per set (15 versus the students' 10). Unlike the students, Shuar in this sample typically had little or no formal training in math. That they nonetheless answered consistently suggests that their decisions were also guided by a precise variable for making welfare tradeoffs. However, the Shuar did not discriminate in their ratios among friends, acquaintances, and siblings; we return to this in the general discussion.

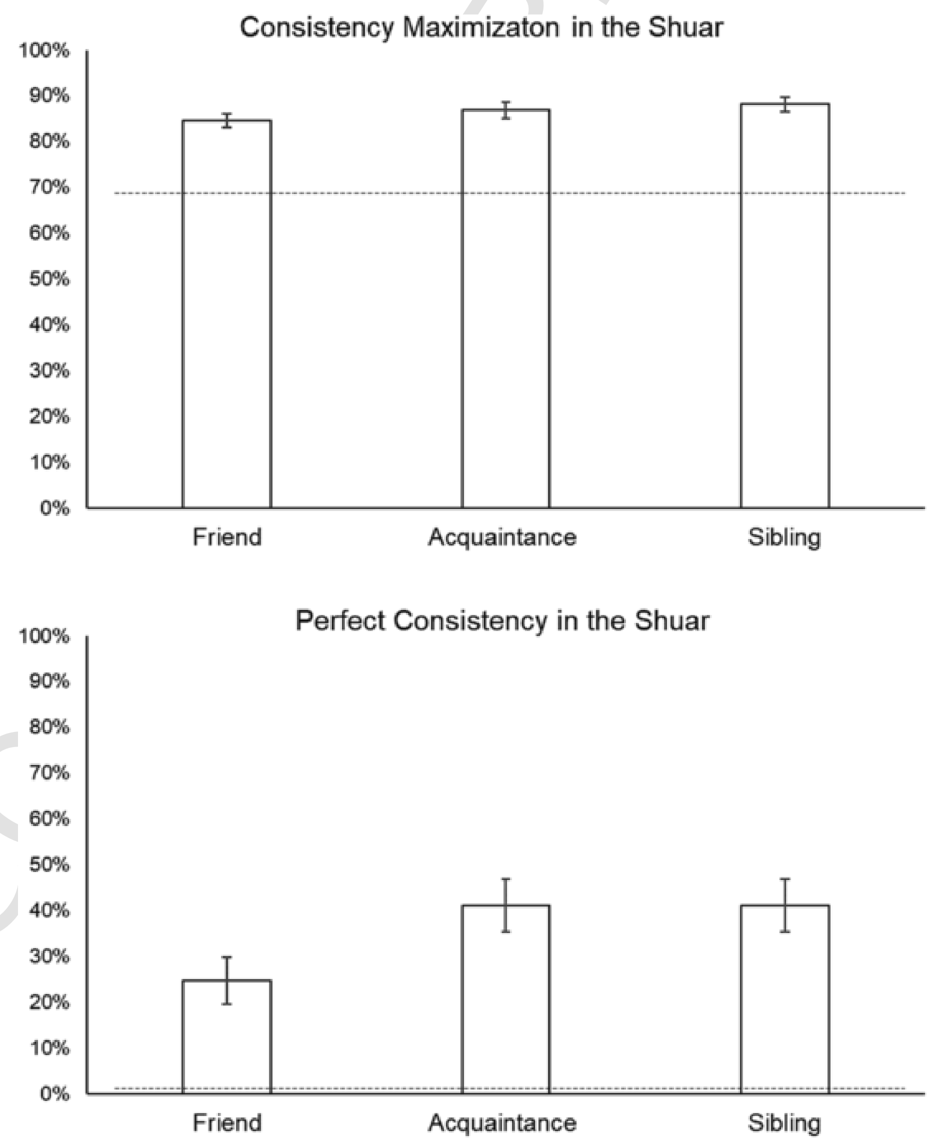

Fig. 6. Consistency Maximization (top panel) and Perfect Consistency (bottom panel) among the Shuar of Ecuador (Study 3). The dashed lines represent random responding of 68% and 0.05%, respectively. Error bars are SEMs.

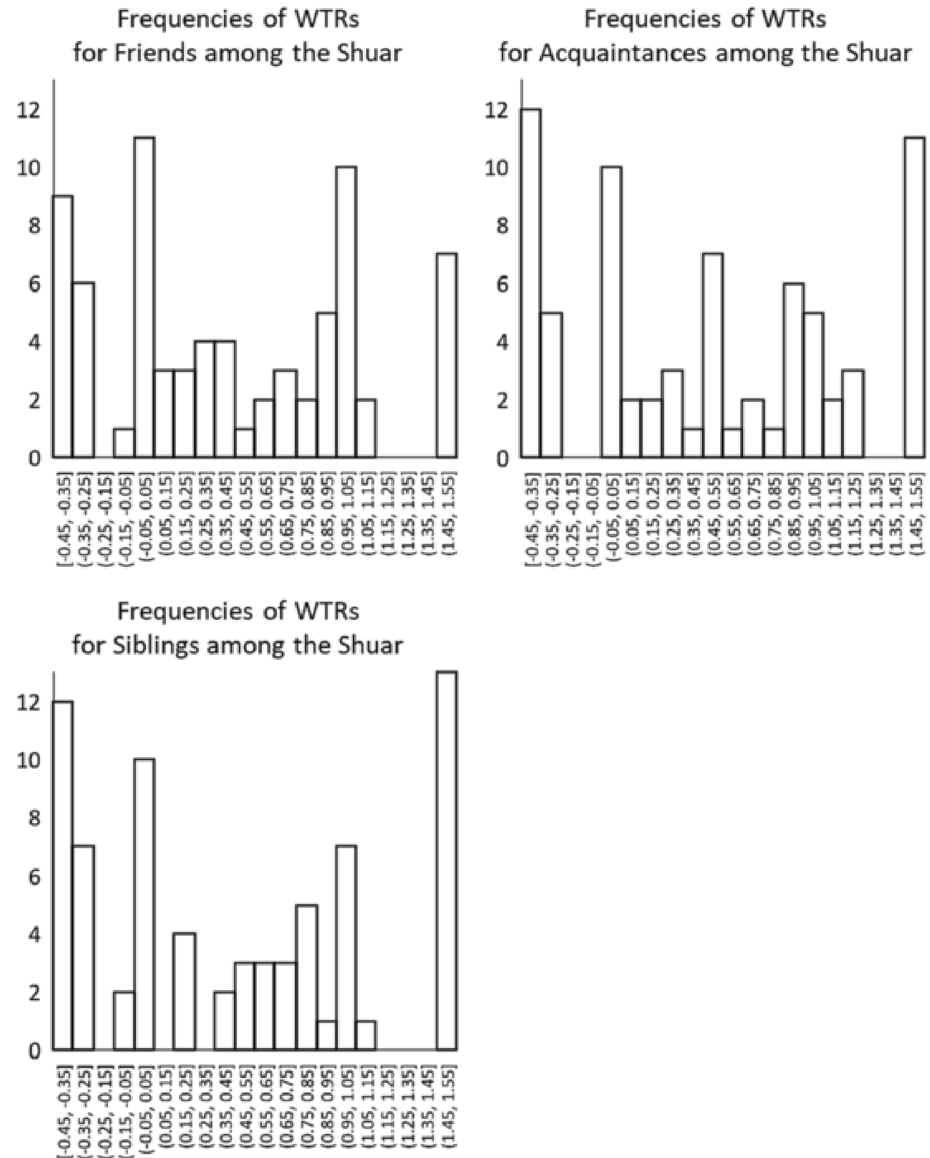

Fig. 7. Frequency Histograms of Welfare Tradeoff Ratios in the Shuar of Ecuador (Study 3).

4. Study 4: Tsimane forager-horticulturalists in the Bolivian Amazon

For our final study, we again collected data from a small-scale society: Tsimane forager-horticulturalists from the Bolivian Amazon. The method differed from the previous studies in several ways. First, instead of money, the Tsimane made decisions expressed in terms of hypothetical kilograms of rice. Second, we did not give everyone a fixed series of decisions. Instead, we used a dynamic titration method. We first asked a Tsimane participant to make a tradeoff between 1 kg of rice for self or 1 kg for the other person. If they gave to the other person, we then changed the value for the decision-maker: 2 kgs for self or 1 kg for the other. As we describe more below, this allowed us to hone in on an estimated welfare tradeoff ratio. This method enabled us to test whether Tsimane participants reveal different ratios for different people.

Because of the change in method, we cannot calculate consistency as in Studies 1–3. We note that Tsimane participants seemed to find the task intuitive and completed it easily.

Lastly, while in Studies 1–3 participants were invited to think of a specific person of their choice, in this study the experimenter (AVJ) chose the others. Two were real members of the same community. An additional two were hypothetical: one unrelated, unknown Tsimane from a different community and one non-Tsimane (*napo'*).

4.1. Methods

4.1.1. Participants

We interviewed 23 Tsimane (3 female; average age = 44 with a range of 18 to 76). All interviews were conducted by AVJ in two Tsimane communities in July and August of 2011. Interviews were conducted in the Tsimane language with the help of a bilingual (Tsimane/Spanish) research assistant.

4.1.2. Ethnographic context

The Tsimane are an Indigenous population of about 17,000 living in lowland Bolivia (Gurven et al., 2017). They produce over 90% of their calories through swidden horticulture (mostly rice, plantains, and sweet manioc), hunting, and fishing. They also interact with the local market economy through occasional wage labor and cash cropping (Kraft et al., 2018). The typical residential unit is a cluster of 2–3 closely related households that daily share food and labor (Hooper, Gurven, Winking, & Kaplan, 2015; Jaeggi, Hooper, Beheim, Kaplan, &

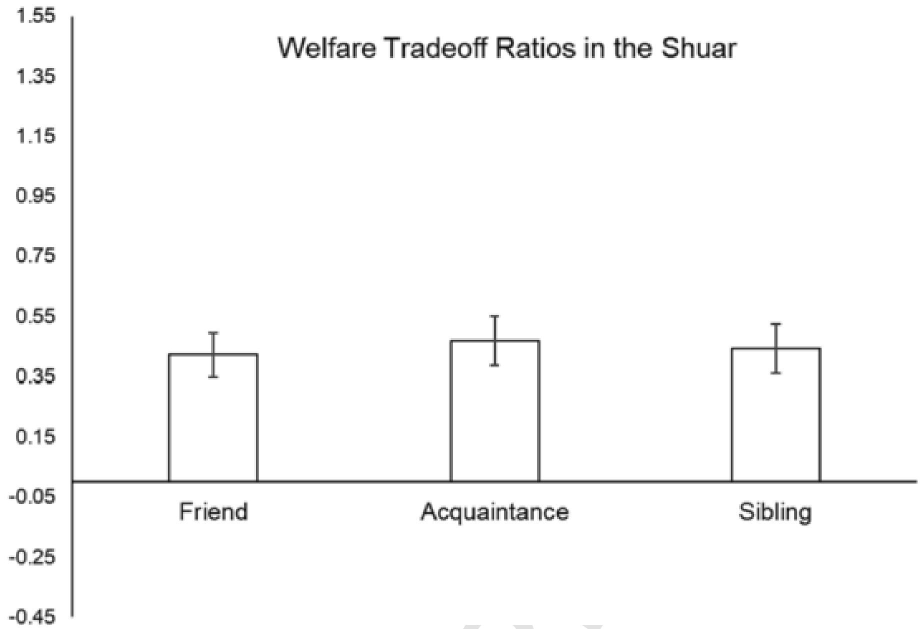

Fig. 8. Welfare Tradeoff Ratios in the Shuar of Ecuador. Bars indicate mean Welfare Tradeoff Ratios. Error bars are SEMs.

Gurven, 2016). Communities typically have several such clusters along with a school and soccer field. People occasionally share some foods (especially meat) and labor with members of other clusters (Jaeggi et al., 2016). Tsimane cherish social visits ("*sóbaqui*") between households, which are often facilitated by the brewing of sweet manioc beer ("*shocdye*") (Hooper, DeDeo, Caldwell Hooper, Gurven, & Kaplan, 2013). The community is also the most salient scale of status competition: People who have more social support and wield more influence in community meetings can resolve conflicts in their favor (which, in recent years, increasingly occur over access to land for horticulture) and enjoy better health and more children (Alami et al., 2020; Jaeggi et al., 2021; von Rueden et al., 2014; von Rueden, Gurven, & Kaplan, 2011).

4.1.3. The welfare tradeoff task

For the Tsimane, we used hypothetical stakes measured in kilograms of rice. Money was avoided because Tsimane life is dominated by informal exchanges of food and labor rather than by cash. Cash is typically only earned and used with non-Tsimane. The interviewer illustrated the stakes with pictures of a bag of rice printed on paper cards. The interviewer would show as many of these cards in each hand as were at stake for the decision-maker and the other person (e.g., one card in one hand and two in the other).

The set of decisions and the people affected differed from our other studies. We did not used a pre-determined set of decisions. Instead, we used a dynamic titration method wherein each interview started with the choice of 1 kg of rice for self or 1 kg of rice for other. The interviewer modified the payoffs on the fly, to hone in on people's suspected switchpoint. For instance, if participants chose themselves when the benefit to self versus the benefit to other was 1:1, then the next question would increase the payoff to the other (e.g., 1:2, 1:3, etc.) until the participant gave rice to the other. After this, the relative amount for the self would be increased (e.g., 2:5, 2:4, etc.) until the participant switched back to themselves. There were about 5–10 decisions that each participant made toward a specific other person. Once a participant switched from taking to giving (e.g., from giving to self to giving to other when the ratio reached 1:3), more extreme values consistent with that switchpoint (e.g., 1:5, 1:7, etc.) were typically not probed. This makes it impossible to apply the same consistency measures used in the previous studies. The maximum ratios were 10:1 and 1:10. Some participants never switched.

We calculated welfare tradeoff ratios using the same algorithm as in the other studies. Nonetheless, there are two important differences. First, although this experiment used 34 distinct ratios for self versus other, any particular person responded only to the subset of ratios necessary to titrate their switch point (Table 3). In principle, this method could detect up to 35 distinct ratios. We estimated the welfare tradeoff ratio for people who never switched in a similar way as before: They were assumed to be 10 and 0, the upper and lower bounds. We found the best fitting ratio given the choices made, using the same method as in the other studies. (The method is able to find the best fitting switchpoint even with missing values. So, the fact that each participant answered only a subset of decisions does not prevent us from assigning ratios.)

A second difference is that some Tsimane participants made multiple decisions about the same underlying ratio. For instance, they may have been asked about the ratio of 1:1 multiple times: 1 kg for you or 1 for them? 2 for you or 2 for them? 3 for you or 3 for them? If the person made the same choice every time, we simply used that choice for scoring. Otherwise, we coded the choice based on the majority of their decisions (e.g., scoring as "giving to self" if they gave to self on two of three trials). If their choices were equally split, however, we coded that as missing data (e.g., if among 4 choices of a 1:1 ratio, 2 were for self and 2 were for other, then the data were coded as missing for that point).[3]

Everyone made decisions about two other Tsimane that they knew personally. These were chosen by the interviewer; usually one was a close relative (parent, child, or in-law) that were known to have shared food with the participant in the past, and the other was a more distant community member with whom the participant had not been observed to share food. (For 9 Tsimane, the two people were both from the same category.) Some people also answered a series of questions about past interactions with these two others, such as social visits, food sharing, or other forms of cooperation in the past month; they reported more such interactions for close relatives ($M = 3.46$) than for distant community members ($M = 1.53$, $t(22.84) = 2.95$, $p = .007$).

[3] Participants did not always make the same decision at the same ratio. Is this evidence of inconsistency? Possibly. However, the amounts at stake can matter for making welfare tradeoffs, so there can be principled reasons why someone may have made different choices across decisions with the same ratio (see cites in Section 1.1).

Table 3
Amounts of rice at stake and possible welfare tradeoff ratios (WTRs) for community participants among the Tsimane.

<table>
<tr><th colspan="2">Tsimane
Study 4</th></tr>
<tr><th>Ratios of Kilograms of Rice
Self:Other</th><th>Possible WTRs</th></tr>
<tr><td>10:1</td><td>10</td></tr>
<tr><td>8:1</td><td>9</td></tr>
<tr><td>6:1</td><td>7</td></tr>
<tr><td>5:1</td><td>5.5</td></tr>
<tr><td>4:1 | 8:2</td><td>4.5</td></tr>
<tr><td>3:1 | 6:2</td><td>3.5</td></tr>
<tr><td>5:2</td><td>2.75</td></tr>
<tr><td>7:3</td><td>2.42</td></tr>
<tr><td>2:1 | 4:2 | 6:3</td><td>2.17</td></tr>
<tr><td>5:3</td><td>1.83</td></tr>
<tr><td>3:2 | 6:4</td><td>1.58</td></tr>
<tr><td>4:3</td><td>1.42</td></tr>
<tr><td>5:4</td><td>1.29</td></tr>
<tr><td>6:5</td><td>1.23</td></tr>
<tr><td>1:1 | 2:2 | 3:3 | 4:4</td><td>1.1</td></tr>
<tr><td>5:6</td><td>0.92</td></tr>
<tr><td>4:5</td><td>0.82</td></tr>
<tr><td>3:4</td><td>0.78</td></tr>
<tr><td>2:3 | 4:6</td><td>0.71</td></tr>
<tr><td>3:5</td><td>0.63</td></tr>
<tr><td>4:7</td><td>0.59</td></tr>
<tr><td>1:2 | 2:4 | 3:6</td><td>0.54</td></tr>
<tr><td>3:7</td><td>0.46</td></tr>
<tr><td>2:5</td><td>0.41</td></tr>
<tr><td>3:8</td><td>0.39</td></tr>
<tr><td>1:3 | 2:6</td><td>0.35</td></tr>
<tr><td>2:7</td><td>0.31</td></tr>
<tr><td>1:4 | 2:8</td><td>0.27</td></tr>
<tr><td>1:5</td><td>0.23</td></tr>
<tr><td>1:6</td><td>0.18</td></tr>
<tr><td>1:7</td><td>0.15</td></tr>
<tr><td>1:8</td><td>0.13</td></tr>
<tr><td>1:9</td><td>0.12</td></tr>
<tr><td>1:10</td><td>0.11</td></tr>
<tr><td></td><td>0</td></tr>
</table>

Note. There were 34 possible ratios of rice, but each participant only saw a small percentage of these, about 5–10. Some ratios had multiple instantiations (e.g., 1:1, 2:2, etc.). There is necessarily one more possible welfare tradeoff ratio than decisions within a set. Each possible WTR represents the WTR that would be assigned if a participant was perfectly consistent and switched from keeping to giving in the decisions in the same row and the row above each possible WTR. See Fig. 1 for more explanation. The exceptions are that the top and bottom possible WTRs correspond to never switching.

Eighteen of the 23 participants also made allocation decisions regarding two hypothetical others, an unknown Tsimane person from a different community whom they had never met and with whom they did not have any kinship ties, and an unknown non-Tsimane person ("*napo*"") from the nearby market town of San Borja. The latter category was particularly likely to elicit no switch from self to other because most Tsimane' experience *napo's* as wealthier than themselves and sometimes have negative experiences with them. Thus, the total sample consisted of 82 pairs (23 * 2 = 46 pairs with real others plus 18 * 2 = 36 pairs with hypothetical others).

4.1.4. Analysis and interpretation

Due to field constraints, we were only able to collect data from a small number of people. Thus, we focus on effect sizes in our interpretations. Traditional hypothesis tests will be underpowered for all but the largest effects. Readers should therefore treat these results as tentative.

4.2. Results

Fig. 9 graphs the distribution of welfare tradeoffs ratios. In many cases, the means were approximately 1.5, except the mean for hypothetical outsiders was 0.65. (medians ≈ 0.70, except the median for hypothetical outsiders was 0). This implies much generosity: a willingness to forgo receiving 3 kgs of rice so that the other person could have just 2 kgs of rice, for example. Next, we examine the three most obvious ways that ratios might vary.

First, are the Tsimane more willing to sacrifice for a hypothetical Tsimane than a hypothetical non-Tsimane? Yes, as shown in Fig. 10 Tsimane revealed a very large average ratio of 1.59 to a hypothetical Tsimane person but a much smaller ratio of 0.65 to a hypothetical non-Tsimane person (*SD*s = 3.1 and 2.3). The effect was medium in size, Cohen's $d = 0.41$ (the difference was marginally significant in a conventional test: paired-sample $t(17) = 1.74$, two-tailed $p = .10$).

Second, do the Tsimane treat the two real Tsimane differently? This analysis has a very small sample size because only 14 people answered for two others that belonged to different categories. Descriptively, Tsimane participants were more willing to sacrifice for closer than more distant community members, with ratios of 1.52 versus 1.28, respectively (*SD*s = 1.5 and 1.6); see Fig. 10. The effect was small, Cohen's $d = 0.10$ (paired-sample $t(13) = 0.37$, two-tailed $p = .72$), but in line with reported differences in cooperative interactions (see above).

Third, were the Tsimane more willing to sacrifice for a real community member compared to a hypothetical non-Tsimane person? We conducted this analysis twice, once comparing the hypothetical outsider to the relatively close community members and once to the more distant members. For participants whose two real others were from the same category (e.g., both siblings), we randomly assigned one to be close and one to be distant; this allowed us to maximize our data ($n = 18$). Tsimane were more willing to sacrifice for real community members than hypothetical non-Tsimane. Using close community members as the contrast, the ratios were 1.76 for community members versus 0.65 for hypothetical non-Tsimane (*SD*s = 2.5 and 2.3). The effect was medium, Cohen's $d = 0.43$ (the difference was marginally significant in a conventional test: paired-sample $t(17) = 1.8$, two-tailed $p = .09$). Using distant community members as the contrast, the ratios were 1.62 for community members versus 0.65 for hypothetical non-Tsimane (*SD*s = 2.6 and 2.3). The effect was small, Cohen's $d = 0.26$ (the difference was not significant: paired-sample $t(17) = 1.1$, two-tailed $p = .29$).

Altogether we found that the Tsimane had no difficulty making sense of this task and that they revealed at least some differences in their welfare tradeoff ratios toward different people that were consistent with reported differences in cooperative interactions.

5. General discussion

Does the mind compute a series of precise variables for deciding whether to help or harm? If so, people should make decisions that are consistent with a specific parameter, their welfare tradeoff ratio. Our results show that people do indeed make consistent choices. US and Argentine students and Shuar forager-horticulturalists all decided very consistently. Tests of consistency were not possible for Tsimane forager-horticulturalists, but they found the task straightforward and intuitive. These findings are in line with the hypothesis that the conscious simplicity of helping or harming is made possible by a precise, nonconscious summary variable.

5.1. Does the mind compute different welfare tradeoff ratios for different people?

We expected that people would reveal more generosity—higher welfare tradeoff ratios—for some categories of people compared to oth-

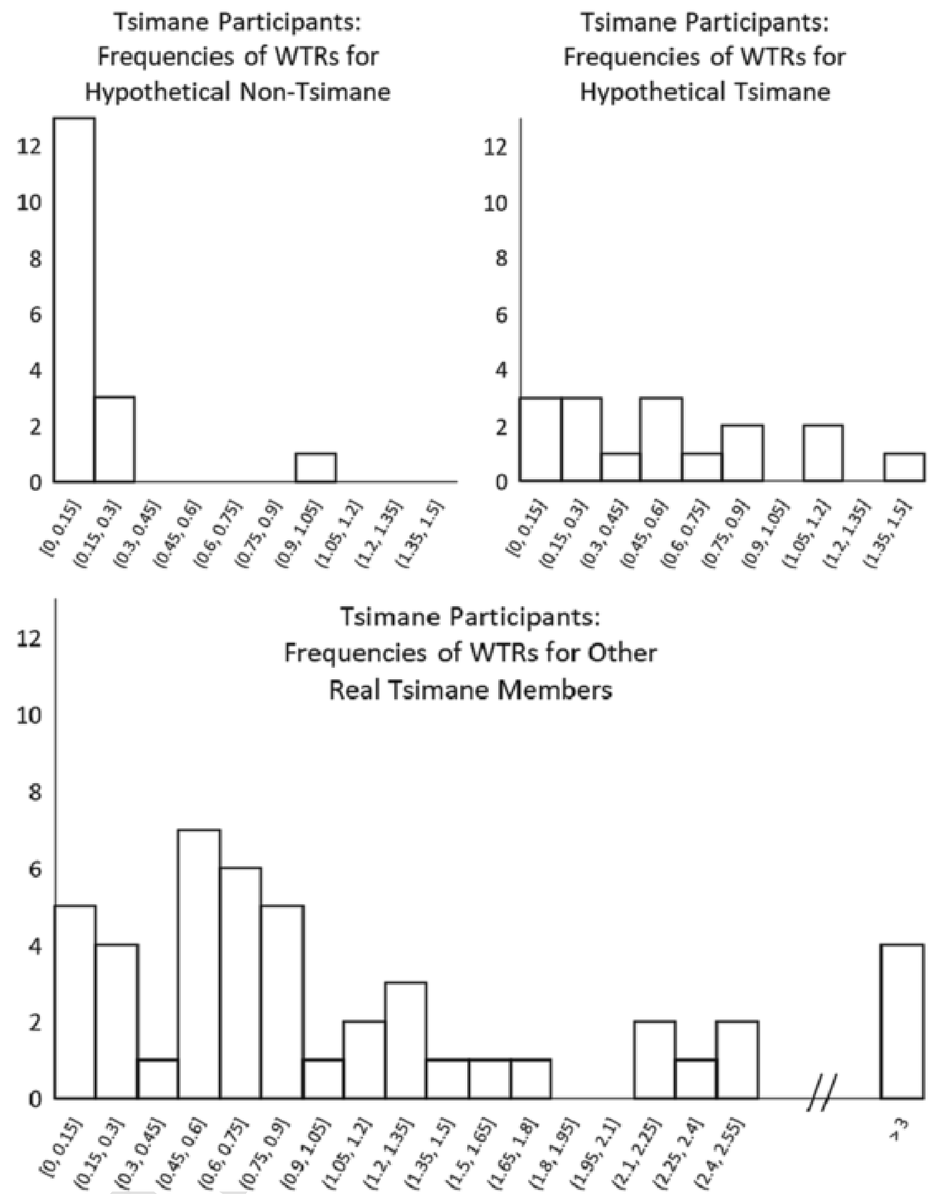

Fig. 9. Frequency Histograms of Welfare Tradeoff Ratios in the Tsimane of Bolivia (Study 4). Not shown are three data points for hypothetical others: Two people had WTRs = 10 for the hypothetical Tsimane from a different community and one of these also had a WTR = 10 for the hypothetical non-Tsimane outsider. In the graph for real community members, the ">3" category includes 4 values, WTRs of 6.04, 6.58, 10, and 10.

ers. This was true for students in the US and Argentina: They were more generous for friends than acquaintances, as shown by higher welfare tradeoff ratios. And Tsimane were more generous to other Tsimane than to outsiders, and more generous to close partners than more distant community members, again as shown by higher welfare tradeoff ratios.

But the Shuar did not discriminate among siblings, friends, or acquaintances with their ratios. This null finding might make sense given their historically high rates of homicide (up to 50% of male deaths in the mid 20th century). High homicide rates incentivize people to shore up their alliances, such as with generosity, as a safeguard against violence (Patton, 2005). Thus, the Shuar might value weak ties, which could explain generosity even toward acquaintances. And the desire to signal generosity might be greater in times of conflict. In the months just preceding this study, there were several deaths, some definite homicides and some suspected ones, rumored to be related to disputes over land and mates, although it is unclear whether the perpetrators were Shuar or outsiders. We also found in debriefing that at least one participant wanted to establish a friendship with a popular young woman and was therefore motivated to give more to this distant acquaintance than to a sibling or friend.

More broadly, welfare tradeoff ratios toward acquaintances might be high if people need to cultivate cooperation with others beyond close friends and kin (Yamagishi & Yamagishi, 1994). Our informal observations suggest that Tsimane participants made decisions implying higher welfare tradeoff ratios toward in-laws than toward biological kin (which were here both subsumed within the "close" category). Helping in-laws is consistent with widespread bride-service among the Tsimane. Although our participants generally valued socially distant others less than socially close ones, in places where weak ties are important, this difference was attenuated. Shuar, too, practice matrilocal bride-service, as well as preferential cross-cousin marriage, a social organization that makes alliances through marriage important and that also makes one's same-sex sibling both an ally and a mating competitor (Chagnon, 1996).

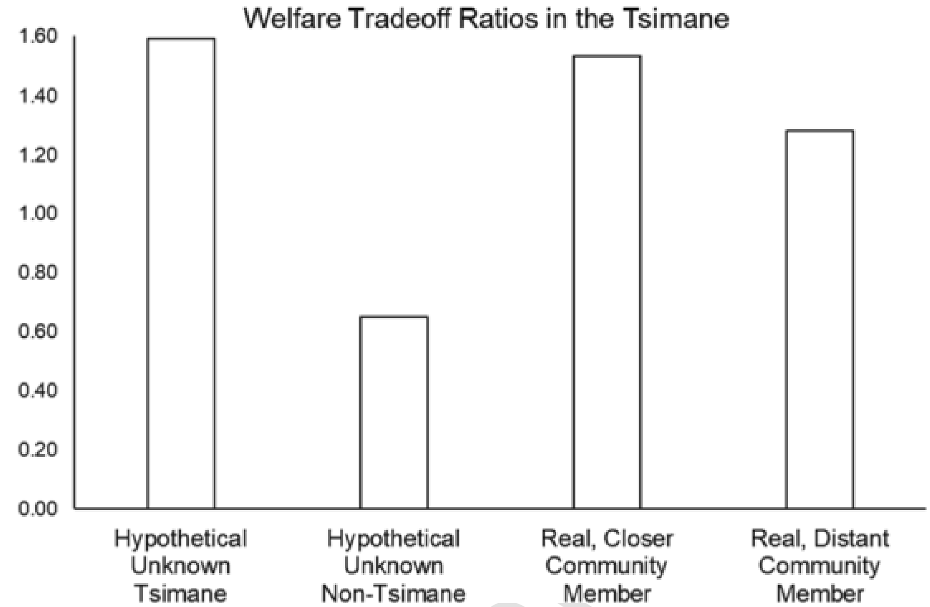

Fig. 10. Welfare Tradeoff Ratios in the Tsimane of Bolivia. For the hypothetical bars, $n = 18$; for the real community member bars, $n = 14$. Bars indicate mean Welfare Tradeoff Ratios. Because of the small sample sizes, SEMs are very large and for clarity we omit them.

5.2. Could other theories explain our results?

We interpret our data as revealing the operation of a precise summary variable that guides people's decisions to help or harm. But other explanations are possible. We consider three: simple heuristics, focal points, and social preferences.

Some researchers have proposed that *simple heuristics* can explain how people make financial decisions (Brandstatter, Gigerenzer, & Hertwig, 2006). Rather than explaining tradeoffs over welfare, the goal of these heuristics is usually to explain how people make tradeoffs involving risk or time: Would you prefer $5 for sure or a 10% chance of $40? Would you prefer $5 now or $40 in a year? Advocates of simple heuristics argue there is no need to assume that the mind has complex rules for integrating different pieces of information. For instance, an integration theory might argue that the mind multiplies values by risk and then selects the option with the largest expected value: $5 * 100% versus $40 * 10% leads to $5 versus $4; thus, select the option of $5 for sure. This is a lot of math. Perhaps the mind avoids it by using a series of rules, none of which requires more than simple comparisons. For instance, if the amount of one option is sufficiently large, take that option. In our example, the decision-maker could stop here: $40 is much bigger than $5, so choose the $40 option without considering how risky it is. But if the amounts are too close, take the option that is less risky.

The way people make decisions speaks against simple heuristics. Evidence from neuroimaging shows that our representations of value are quantitatively precise, integrating amounts, risks, and time delays (Glimcher, 2022; Kable & Glimcher, 2007; Preuschoff, Bossaerts, & Quartz, 2006). Although similar studies have not been done with welfare tradeoff ratios, social relationships are at least as important in human evolution as time and risk. Thus, we suspect that just as the mind can perform exact computations for navigating time and risk, it can perform exact computations also for deciding to help or harm. Evidence for this conjecture comes from research on how people trade off welfare for others who are increasingly socially distant (Jones & Rachlin, 2006; Rachlin & Jones, 2008a). These studies reveal that the mathematical relationship between social distance and valuing others' welfare mirrors the complex relationship between time delay and value. Other studies show that people can rationally integrate different moral values to arrive at coherent judgments about complex moral dilemmas (Guzmán, Barbato, Sznycer, & Cosmides, 2022). Our own data are also difficult to explain with heuristics: It's difficult to see how our participants could be highly consistent in their choices if they were following rough heuristics.

The simple heuristics approach might also predict that people should use clear, simple values to make their tradeoffs: For instance, give nothing (WTR = 0), give when the other gets more (WTR = 1), give when the other gets twice or more (WTR = 0.5), or give unless you get twice or more (WTR = 2). The actual distributions of welfare tradeoff ratios in our studies are shown in Figs. 4,7, and 9. Participants revealed many values, not just these simple ones. Perhaps simple heuristics, using a few simple values, explain some of our participants' choices, but we do not think they can explain all of them.

These simple heuristics focus on the process inside a single person's mind. A related alternative hypothesis focuses on the need for simplicity to enable coordination in groups. We call this the *focal points* hypothesis (Schelling, 1960). It's a difficult problem for groups of people to decide what counts as fair sharing. To solve this problem, people might settle on clear, easily understood points at which to share—focal points. Different cultures may settle on different norms—different focal points—for how to divide resources (Chudek & Henrich, 2011; Richerson & Boyd, 2005). The norms could be complex, specifying what to do with particular types of resources (e.g., cash versus food) and for particular categories of relationships (e.g., community members versus trading partners) (Fiske, 1992). Even allowing this complexity, however, our data speak against the focal point hypothesis. As shown in Figs. 4, 7, and 9, people usually reveal ratios throughout the possible range. (The one exception is that almost uniformly the Tsimane did not want to share anything with a hypothetical outsider.) There are no obvious, culturally consensual focal points in our data.

The final alternative we consider is the hypothesis of *social preferences*. Social preferences are general dispositions to consider the welfare of other people. As Fehr (2009, p. 216) defines them, a social preference is "a characteristic of an individual's behavior or motives, indicating that the individual cares positively or negatively about others' material payoff or well-being…the individual takes the welfare of the other individuals into account." On this definition, there is an obvious difference between social preferences and welfare tradeoff ratios: A person applying a social preference applies it to *every person they interact with*, or at least broad categories of people. In contrast, a person using a welfare tradeoff ratio is applying it to a *specific other person, at a specific* *moment in time.* In his description of social preferences, Fehr (2009, p. 221) explicitly cautions that social preferences cannot be studied using experiments that allow players to know each other or earn reputations—such knowledge would make whatever behavior is observed irrelevant to general social preferences.

Alternatively, a researcher could define social preferences in a way that allows them to be distinct for different people. But we think there is still a difference: Standard theories of social preferences provide little guidance on how the value of a social preference is determined. The broader hypothesis of welfare tradeoff ratios provides this guidance. It does so by drawing on theories about social evolution, like kin selection or reciprocity (see cites in Section 1.1 as well as Gervais, 2017; Henrich, 2004).

Altogether, we do not think simple heuristics, focal points, or social preferences can explain our data as well as welfare tradeoff ratios do.

5.3. How might research on welfare tradeoff ratios move forward?

Although not our focus here, other research tests for the reality of welfare tradeoff ratios in another way: by showing that many emotions function to recalibrate these variables in the minds of oneself and others. For instance, anger appears designed to cause the angry person to bargain for more favorable ratios when treated more poorly than expected (Sell, 2011; Sell et al., 2017; Sell, Tooby, & Cosmides, 2009; Sznycer, Sell, & Dumont, 2021). Importantly, this work shows that what matters for anger is the *ratio* of harm inflicted to benefit gained, and not just harm by itself, supporting the interpretation that anger functions to recalibrate welfare tradeoff ratios (Sell et al., 2017). Other research looks at welfare tradeoff ratios in forgiveness and gratitude (Burnette, McCullough, Tongeren, & Davis, 2012; Forster, Pedersen, Smith, McCullough, & Lieberman, 2017; McCullough, Kurzban, & Tabak, 2013; McCullough, Pedersen, Tabak, & Carter, 2014; Smith, Pedersen, Forster, McCullough, & Lieberman, 2017). Other work studies shame and pride (Robertson, Sznycer, Delton, Tooby, & Cosmides, 2018; Sznycer et al., 2012, 2017; Sznycer et al., 2016; Sznycer & Cohen, 2021). Still other work uses welfare tradeoff ratios to understand compassion, disgust, awe, enthusiasm, and beyond (Del Ponte et al., 2021; Delton, Petersen, DeScioli, & Robertson, 2018; Kirkpatrick, Delton, Robertson, & de Wit, 2015; Monroe, 2020; Sznycer, Delton, Robertson, Cosmides, & Tooby, 2019; Tybur, Lieberman, Fan, Kupfer, & de Vries, 2020). Like sights and sounds, emotions largely come unbidden to consciousness and feel transparent. Nonetheless, many appear to be underwritten by complex computations that center around welfare tradeoff ratios.

An open question is the role of welfare tradeoff ratios in the psychology of reciprocity. Direct reciprocity involves the exchange of benefits and favors between two people or groups (Axelrod & Hamilton, 1981; Trivers, 1971). Most instances of reciprocal exchange in humans and nonhuman animals involve established relationships within which the exact values of exchanged goods or services are not tracked explicitly and there is no conscious expectation of reciprocation; rather, a history of past interactions serves to establish trust and a statistical expectation of reciprocation (Brosnan & de Waal, 2002; Jaeggi & Gurven, 2013; Schino & Aureli, 2010; Xue & Silk, 2012). This trust may be underwritten by knowledge that the partner has a non-zero welfare tradeoff ratio for the self, which could be established through repeated interactions with increasing stakes (Roberts & Sherratt, 1998). The precise values of the ratios may be occasionally re-negotiated, as the above hypotheses about emotions suggest. As a first step, our Tsimane data indicate that people do have higher ratios toward others they regularly cooperate with. The difference between friends and acquaintances in the US and Argentine samples suggests the same, even though we don't have data about actual cooperative exchanges within those relationships. On the other hand, when exchanges are more explicit, such as in market transactions ("I'll trade my fish for your grain"), welfare tradeoff ratios might play little role. For instance, welfare tradeoff ratios play no role in a leading theory of exchange (Cosmides & Tooby, 1992, 2015). Cheating is cheating, whether the cheater is a stranger for whom your ratio hovers near zero or a friend for whom your ratio is positive.

It's also an open question what role welfare tradeoff ratios play in the psychology of reputation and indirect reciprocity (Barclay, 2013; Nowak & Sigmund, 2005; Romano, Balliet, & Wu, 2017; Wu, Balliet, & Van Lange, 2016). Most obviously, you are more likely to assign a high ratio to someone with a good reputation, even if you have never interacted with them directly, because that good reputation signals a high chance of recouping one's investment. We likely also have psychological abilities for managing the ratios that people in our wider community compute about us. Emotions of shame and pride, among others, appear designed to do this—shame being activated when others devalue us and pride to advertise when they should value us (see above cites).

There are other outstanding issues for welfare tradeoff ratios. Consider again the proposed decision rule to take an action (e.g., helping another person) when:

$$\text{WTR} > \text{Amount for Self} / \text{Amount for Other} \quad (1)$$

We want to stress that this is a simplification and will not always give the correct result. What would happen if both variables representing the welfare at stake were to change by the same proportion? Nothing, at least according to the equation. A ratio of 1/2 is the same as 2/4, 10/20, 300/600, and so on. But research suggests that the overall amount of welfare at stake can affect how willing people are to trade off their own welfare for others (Delton, 2010). You might be willing to forgo $1 to deliver $1 to an acquaintance, but what about forgoing $100 to deliver $100, or $1000 to deliver $1000? Moreover, it matters whose welfare is at stake: When trading off against kin, people become *more* willing to trade off their own welfare as the stakes rise; when trading off against non-kin, people become *less* willing as the stakes rise (Ostaszewski & Osiński, 2011; Stewart-Williams, 2007; Xue, 2013). A more complex functional form than a simple ratio is needed to capture this (as researchers are also doing for the psychology of time discounting; see Vincent, 2016).

Another, related way this equation could fail appears when the effects on welfare are extreme. For instance, actions that could cause the death of a friend or family member might be almost always avoided, even if the self could gain substantially. Eq. 1 describes a linear relationship between how personal welfare substitutes with welfare for another person. But at least at the extremes the mental equation is likely not linear. Instead, the amount of welfare gains the decision-maker must receive to harm or forgo helping someone else might become proportionally larger as welfare effects for the other person become extreme. (This is analogous to the way economists think about indifference curves that relate quantities of two goods: Instead of a linear relationship describing how two goods substitute with each other, indifference curves for many goods are convex to the origin.)

As research progresses, we expect that more will be learned about how the mind computes welfare tradeoff ratios. This will likely include demonstrations that the relationship between one's own welfare and the welfare of others is not a simple ratio. Because the term *welfare tradeoff ratio* has been used by us and others in the literature, we are loath to suggest a change in terminology. But eventually a new name may become necessary to accurately capture what the mind is up to. If so, one simple rechristening would be to call it a *welfare tradeoff variable*, a summary variable computed by the mind that captures how to trade off one's own welfare to help or harm someone else—but with no implication it takes exactly a ratio form.

A final issue is a limitation of the theory. We have spoken of "precise" variables. But of course, all mental magnitudes have some error and uncertainty associated with them. And welfare tradeoff ratios are themselves computed from variables that carry uncertainty (e.g., estimates of genetic relatedness), increasing the imprecision. So, what counts as precise enough? The theory is silent on this. For the current results, although we have reported standard inferential statistics, we think the most important test is the "interocular test"—the level of consistency leaps from the graphs and hits the reader between the eyes. Nonetheless, defining precision more precisely is a useful goal for the future.

5.4. Conclusion

Cooperation and altruism were once seen as mysteries incompatible with natural selection. How could an organism increase its own survival and reproduction by sacrificing for others? This is a mystery no longer. In the century and a half since Darwin revolutionized the study of life, biologists have discovered a surfeit of reasons why humans and other organisms might help others, even if that help appears costly (for a recent review, see Raihani, 2021). We contribute to this body of evidence by drawing closer the tangled banks of evolutionary biology and cognitive science. Kinship and competition, among many other reasons, explain why animals would evolve over deep time to help or defer to others. Welfare tradeoff computations, among many other pieces of our psychology, provide the cognitive foundations that determine when people behave with kindness, indifference, or violence in the here and now.

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