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Animal behaviour

Local competition sparks concerns for fairness in the ultimatum game

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Humans reject uneven divisions of resources, even at personal cost. This is observed in countless experiments using the ultimatum game, where a proposer offers to divide a resource with a responder who either accepts the division or rejects it (whereupon both earn zero). Researchers debate why humans evolved a psychology that is so averse to inequity within partnerships. We suggest that the scale of competition is crucial: under local competition with few competitors, individuals reject low offers, because they cannot afford to be disadvantaged relative to competitors. If one competes against the broader population (i.e. global competition), then it pays to accept low offers to increase one's absolute pay-off. We support this intuition with an illustrative game-theoretical model. We also conducted ultimatum games where participants received prizes based on pay-offs relative to immediate partners (local competition) versus a larger group (global competition). Participants demanded higher offers under local competition, suggesting that local competition increases people's demands for fairness and aversion to inequality.

1. Introduction

People react strongly when they are victims of inequity, and often protest or incur costs to reduce inequity within partnerships. Reactions to inequity are frequently studied using the ultimatum game, a standard tool for testing fairness and inequity aversion in empirical studies [1–3] and in theoretical models [4–6]. The ultimatum game is simple: a proposer offers a division of a sum of money to a responder. If the responder accepts, then the money is divided as offered. If responder rejects it, neither receives money. Standard economic theory predicts that responders will accept any non-zero amount, and proposers will offer the minimum non-zero amount. However, this result is not typical in any society studied [1]. Instead, responders often reject low offers, and proposers offer considerably more than the minimum. This striking divergence from game-theoretical predictions is puzzling, and is often taken as evidence for humans' natural sense of fairness [7].

Whatever the psychological mechanisms producing these patterns, we must ask: what selective pressures would result in a psychology that rejects unfair divisions of resources? What is the function of forgoing resources to ensure that one's partner also receives none? Several explanations have been suggested, including: a reputation for rejecting unfairness leads to higher future offers [6] and rejecting unfairness lets one seek better treatment elsewhere within the biological market [4].

Here, we propose another (non-mutually exclusive) solution: interpersonal competition. Put simply, it is bad to have competitors doing better than you. When individuals' social partners are also their main competitors, spite pays off [8]. Rejecting unfair divisions of resources may be symptomatic of this: one gives up money by rejecting low offers, but this ensures that one's interaction partner—who is also one's competitor—misses the opportunity for even more. One's willingness to reject unfairness should thus depend on the scale of competition, i.e. the extent to which one is only competing against one's immediate interaction

partner (local competition) versus also competing against other members of the broader population (global competition; see [8,9]). Perceptions of local competition should cause greater willingness to reject low offers to avoid being disadvantaged relative to a competitor. Perceptions of global competition should cause greater willingness to accept, because giving up money reduces one's competitiveness relative to the broader population.

2. Game-theoretical model

The electronic supplementary material presents an illustrative model of ultimatum game responder behaviour, where a focal responder competes with N group members, including herself. Under extreme local competition, the focal responder only competes against the proposer ($N = 2$); life is a zero-sum interaction between them. Competition becomes more global as $N > 2$. Accepting offers pays off when

$$p > \frac{2}{2N + ak(N-2)}, \tag{2.1}$$

where p is the proportion offered, k is the size of the resource to be divided (relative to a base fitness of 1) and a is the proportion of offers accepted in the population. According to equation (2.1), accepting offers is more advantageous for higher offers (p), larger resources (k), when others are more likely to accept (a), and as the number of competitors (N) increases. This latter finding (figure 1) relates to the scale of competition: one's willingness to accept offers increases as competition becomes more global (i.e. increasing N) relative to when competition is local ($N = 2$).

We experimentally test this with laboratory ultimatum games under different scales of competition that are relatively local ($N = 3$) and more global ($N = 9$). Our model was designed to test acceptances and rejections, not offers, so we have no strong a priori predictions about offers. Under local competition, proposers might prefer to offer less to maximize earnings relative to responders, but need to offer more to have the offer accepted (because responders will demand more). The latter effect may be stronger, because the likelihood of rejections affects offer size [2], but the competing predictions prevent strong predictions about offers.

3. Experimental set-up

(a) Method

(i) Participants

Participants in study 1 were 31 male and 50 female first-year psychology students (mean age = 18.35 years ± s.d. 1.12 years) from the University of Guelph psychology participant pool; study 2 involved 24 males and 156 females (mean age = 18.47 years ± s.d. 1.58 years) from the same population. Sessions consisted of three groups of three participants (i.e. nine people per session) in isolated cubicles interacting via computers using z-Tree software [10]. Participants received credit towards a psychology class, and could also earn money: to facilitate manipulations of the scale of competition, the participants earned points during the experiment, and were told that three participants per session received cash prizes (Canadian $5) for earning the most points (see below). Decisions were anonymous, though the experimenter knew people's earnings.

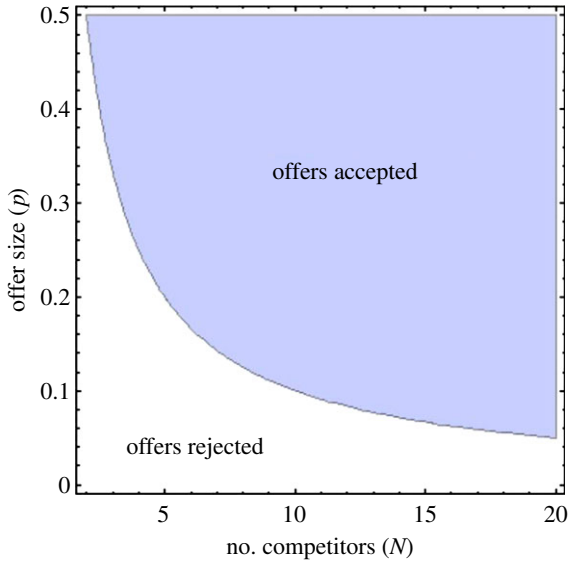

Figure 1. Predicted willingness to accept ultimatum game offers increases as the scale of competition becomes less local and more global (i.e. goes from low to high number of competitors). Shaded area, accepted offers. Light area, rejected offers. Parameters displayed are $a = 0.5$ and $k = 1$. (Online version in colour.)

(ii) Dependent variable: ultimatum game

Each participant made an offer to divide 10 points between herself and another group member. If the offer was accepted, then the points were divided as proposed, but if the offer was rejected, then both earned zero from that interaction. Each participant made one offer and responded to one offer, for example, if A, B, and C were one group, then A offered to B, B offered to C and so on. Participants made offers before responding to them. A participant's total points were the summed earnings from her offer and her response.

The dependent variable was participants' minimum acceptable offer (MAO): participants specified the lowest offer they would accept (0–10). If their partner offered less than that MAO, then the offer was automatically rejected on their behalf, otherwise, it was automatically accepted on their behalf.

(iii) Independent variable: scale of competition

We instituted the scale of competition as in West *et al.* [9]. Under local competition, three $5 prizes went to the single top earner in each of the three groups. This creates incentives to earn more than one's group members, regardless of other groups' earnings. Under global competition, three $5 prizes went to the three people with the most points of all nine people in the whole session, so a three-person group could have multiple winners. This creates incentives to earn as many points as possible, rather than focus on pay-offs relative to group members. If there were ties, then prizes were divided among those tying.

In study 1, participants experienced both conditions (counterbalanced order) for separate pools of $5 prizes in each condition, but with roles reversed (e.g. if A offered to B under local competition, then B offered to A under global competition); participants were not told beforehand about the second condition. After making decisions in the first condition, most participants did not change behaviour for the second condition (65% of MAOs and 44% of offers remained the same). This could be owing to the subtlety of the instructions that differentiated conditions, a desire to be consistent

[11], or other reasons. Because of that strong anchoring from the first decisions, we analysed only the first condition that participants experienced using two-tailed independent-samples *t*-tests (unequal variance). Study 2 replicated study 1 using a between-subjects design to avoid anchoring effects.

(b) Results

As predicted, participants experiencing local competition demanded higher ultimatum game offers than participants experiencing global competition (study 1 mean MAOs: 3.39 ± s.e. 0.20 versus 2.89 ± s.e. 0.14, respectively, $t_{65.23} = 2.01$, $p = 0.049$), with a medium effect size (Cohen's $d = 0.45$). This supports our hypothesis that people reject unfairness more often under local competition than global competition. Because almost all MAOs were between 2 and 5 (20–50% of endowment), this difference represents one-sixth of the entire typical range. Offers were slightly but not significantly higher under local competition than under global competition (study 1 offers: 4.00 ± s.e. 0.16 versus 3.67 ± 0.14, respectively, $t_{79} = 1.54$, $p = 0.13$).

Study 2 replicated these effects: ultimatum game demands were higher under local competition than global competition (study 2 mean MAOs: 3.47 ± s.e. 0.12 versus 3.1 ± s.e. 0.11, respectively, $t_{177} = 2.23$, $p = 0.027$, Cohen's $d = 0.34$), whereas offers did not differ between conditions (study 2 offers: 3.90 ± s.e. 0.10 versus 3.93 ± 0.10, respectively, $t < 1$). Offers did not significantly correlate with MAO in either study 1 or 2 ($r_{79} = 0.077$ and $r_{154} = 0.098$, respectively, both n.s.).

4. Discussion

We proposed that organisms demand more fairness under local competition than under global competition. Our mathematical model and behavioural experiment both support this. In the model, accepting low offers is beneficial if one competes against more individuals than one's immediate partner. In the experiments, participants demanded higher ultimatum game offers when pay-offs depended on score relative to immediate partners (local competition) compared with when pay-offs depended on score relative to everyone in the session (global competition). Local competition did not affect offer size, possibly, because a desire to offer less is offset by a strategic need to offer more.

This model and these experimental results have potential implications for the evolution of fairness and aversion to disadvantageous inequity. They also support previous work showing that local competition reduces cooperation [9] and increases spiteful or competitive behaviour [8], defined broadly. People never compete against infinite populations or entire societies, but instead compete most strongly against local subsets of populations over particular resources, for example, members of the same local subgroup, sex or age competing over mates. Under local competition, it pays to have a psychology that dislikes being disadvantaged (and likes being advantaged) relative to social partners, as they are often competitors. As such, the scale of competition may partly explain why people reject unfairness against them. People often misperceive non-zero-sum situations as being zero-sum [12], so perhaps the demands for fairness in typical bargaining situations result from perceptions of local competition. The standard ultimatum game cannot differentiate between aversion to inequity versus inequality, so future research should differentiate these, for example, with earned but unequal pay-offs.

The scale of competition [8,9] probably varies across time and situations, and is rarely entirely local or global. Given this, it pays to assess the scale of competition and respond accordingly. We show that demands for fairness are indeed sensitive to variations in the scale of competition, just as cooperation levels [9]. If some people face more local competition daily than others, then this would make the former less tolerant of inequality. For example, some people face stronger familial competition for limited parental resources, smaller social niches (e.g. academic disciplines) in which one's potential partners are also one's main competitors, and so on. Future research should test whether inequity aversion and fairness demands are higher among people who live or grew up under conditions of local competition, or who display competitive social value orientations [13]. Future research should also investigate what cues are used to assess the scale of competition, including whether subtle primes of zero-sum relationships can trigger greater willingness to reject unfairness.

Some limitations warrant discussion. First, our within-subjects manipulation was unsuccessful: most participants did not change behaviour between conditions. Participants may have wanted to appear consistent across conditions (see [11]), or perhaps the instructions were too subtle to note the change in the conditions. Nevertheless, two between-subjects experiments produced very similar results, increasing our confidence in the phenomenon. Second, ultimatum game demands are higher in larger communities than in smaller ones [1], potentially in contrast to our results. Larger communities offer larger biological markets [14], which increase demands for fairness, because responders seek better offers elsewhere [4]; this may outweigh any yet unknown effects of community size on the scale of competition. This warrants further investigation to disentangle these effects.

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