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Pseudocompetition among groups increases human cooperation in a public-goods game

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Economic games are often used in an attempt to reveal the underlying preferences or motivations that govern human behaviour. However, this approach relies on the implicit assumption that individuals are rational and fully aware of the consequences of their decisions. We examined behaviour in a standard economic game that is often used to measure social preferences: the public-goods game. We found that giving information to individuals about the relative success of their group led to (1) significantly higher levels of cooperation and (2) emotional responses to group success. This is despite the fact that group success had no effect on the payoffs in our game, and so knowledge of group success should not influence the behaviour of rational players. Consequently, these results suggest that cues of group competition have an automatic or unconscious effect on human behaviour that can induce increased within-group cooperation. More generally, this framing effect emphasizes the potential problem with drawing biological conclusions from the quantitative comparison of cooperation levels in economic games with the predictions of theory. Instead, our results emphasize the advantage of testing theory by qualitatively comparing behaviour across treatments, and with regard to expected adaptations and expected ontogeny.

Economic games are used to examine the behavioural motives and social preferences of humans (Camerer 2003; Fehr & Fischbacher 2003; Henrich et al. 2005). The results of such experiments can be interpreted with either a qualitative or a quantitative approach (Davies et al. 2011). The qualitative approach examines differences in behaviour between treatments, which typically have different payoff structures for the game that is being played. For example, individuals cooperate more when the relative cost of cooperation is decreased (Isaac & Walker 1988). In contrast, the quantitative approach compares the quantitative level of behaviour within a specific game or treatment with that predicted by theoretical models (Levine 1998; Fehr & Fischbacher 2003; Camerer & Fehr 2006). For example, humans cooperate in one-shot economic games at a rate higher than the rate that would maximize their financial gain, which has been argued to suggest that humans are uniquely altruistic in a way that cannot be explained by evolutionary theory (Fehr & Rockenbach 2004; Gintis et al. 2005). The deductions from this quantitative approach typically rely on the implicit assumption that individuals are rational and fully aware of all the consequences of their decisions (Fehr & Fischbacher 2005; Dufwenberg et al. 2011).

However, there is increasing evidence that individuals adjust their behaviour ‘irrationally’, in response to aspects of how the experiment are presented that do not alter payoff structures. Examples of such ‘framing effects’ include individuals showing increased cooperation in the presence of images resembling human eyes (Haley & Fessler 2005; Bateson et al. 2006; Burnham & Hare 2007; Rigdon et al. 2009; Ernest-Jones et al. 2011), or decreased cooperation when a game is labelled the ‘Wall Street game’ instead of the ‘community game’ (Liberman et al. 2004). The point here is that these experimental manipulations do not alter the payoffs of the games, and hence should not alter the strategy that rational individuals play. Consequently, the fact that they do either reveals features of the environment that people find salient when making such decisions (because of learning and/or an evolved predisposition), or suggests which norms and strategic beliefs they hold (Camerer 2003; Henrich et al. 2004; Dufwenberg et al. 2011). Put simply, framing effects show the psychological baggage that people bring to games from the real world, and if they are common, then the quantitative approach will lead to error (Burnham & Johnson 2005; Hagen & Hammerstein 2006; Binmore & Shaked 2010).

We tested whether humans adjust their behaviour in response to cues of competition between groups when playing a standard public-goods game, which is used as a model for collective action problems (Ledyard 1995). Theory predicts that competition between groups can favour cooperation, because more cooperative

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groups will be more successful, and hence will lead to more successful individuals (Hamilton 1975; Choi & Bowles 2007; Bowles 2009). Consistent with this, the implementation of group competition in public-goods game experiments leads to individuals identifying their groupmates as collaborators, and cooperating with them at a higher rate (Nalbantian & Schotter 1997; Baron 2001; Bornstein 2003; Gunnthorsdottir & Rapoport 2006; Tan & Bolle 2007; Puurtinen & Mappes 2009; Burton-Chellew et al. 2010). This suggests that people may be adapted to respond facultatively to cues of group competition. However, this previous experimental work has typically lowered the cost of cooperation, which is known to increase cooperation, and/or explicitly linked payoffs to relative group performance. Therefore we cannot be sure that people respond to cues of group competition per se as opposed to changes in the way costs and benefits are either calculated or presented.

We made participants play a standard public-goods game twice, with the only difference being the information that we provided during the game about how their group did relative to the other groups. In typical public-goods games individuals can contribute monetary units (MU) to a group fund to produce benefits that are shared equally by all members of their group, including themselves, and regardless of differences in contribution levels. In our games, participants were in groups of four, and every MU contributed was doubled by the experimenter before being shared among the four players; thus the individual return on contributions was −0.5 MU for every MU contributed. In each experimental session we also had four such groups of four players, and we made participants play the game for two sets of 10 rounds, with the group compositions randomly shuffled each round. Importantly, our instructions and payoffs were identical for both sets of games (treatments). Instead, we merely varied the additional information we provided to participants after each round of play, by either showing them, in rank order, the contributions and earnings of all four members of their group (‘within-group information’), or the sum contributions and earnings of all four groups, in rank order (‘among-group information’, Fig. 1). This difference between treatments makes no structural differences to the game played (payoffs are unaffected) and thus rational participants should behave no differently. In contrast, if people’s decisions are partly governed by predispositions (‘psychological baggage’), then we expect cooperation to be relatively higher with among-group information. Furthermore, we complemented our behavioural data with measurements of the participants’ emotional responses after each round of decision making.

METHODS

We carried out six experimental sessions, each with 16 participants, at the Centre for Experimental Social Sciences (CESS), Nuffield College, University of Oxford, implemented with z-Tree (Fischbacher 2007). The experimental design and procedure were approved by the CESS. The identity of all participants and their responses were anonymous to the experimenters. Participant payment and recruitment were conducted entirely by the CESS staff, and participants were paid anonymously. The 96 participants had never taken part in an experiment involving public-goods games at CESS and were students (48 females, 46 males, two unknown). We used a standard (linear) public-goods game (Marwell & Ames 1979, 1980; Ledyard 1995), and in each round of play we gave each participant an endowment of 40 MU (100 MU = £1), a fraction of which (0–40 MU) they could contribute to a group project, keeping the remainder. We doubled the sum total of contributed MU for each group, before sharing out the resultant MU equally among the four group members. Thus, for each MU contributed to the group project, each of the four group members received 0.5 MU, including the contributor (who had contributed 1 MU and thus made a net loss of −0.5 MU for every MU contributed).

Our experiment involved two treatments, across which we held the monetary payoffs constant, but varied the information given after each round of play (Fig. 1). In both treatments we reminded participants of their contribution, and informed them of their income from that round, making explicit that their income was the sum total of their retained MU, plus any MU they received back from the group project. This information, along with the sum contributions of their groupmates, was supplied to all participants; it is consistent with the information provided in many public-goods game experiments. Additionally, in the within-group information treatment, we also displayed the same information for all three other group members, ordering the players according to their earnings, with the highest earning player at the top (Fig. 1a), whereas in the among-group information treatment we displayed the same information but at the level of the group rather than at the individual level (Fig. 1b). Consequently, the difference between the two treatments is that the within-group information treatment shows participants how they performed (contributions and earnings) relative to the other members of their group, whereas the among-group treatment, which includes the same information pertaining to the focal individual, also shows participants how their group did relative to all the other groups.

We made each participant play each treatment for 10 consecutive rounds, reversing the order between sessions. In each round we randomly and anonymously assigned the 16 participants to one of four groups of four players, and so reputation effects were not possible (Nowak & Sigmund 1998; Wedekind & Milinski 2000). We presented the same instructions to all participants (available upon request), and started game play only after every participant had successfully completed, with advice when required, a comprehension test (available upon request). At the end of the first treatment, we verbally informed all participants that, ‘You will now play the exact same game again, for the same number of rounds, but this time you will receive different information at the end of each round’. The time delay between treatments was 60 s. Overall, the monetary reward obtained ranged from £6.60 to £13.60 with a mean of £10.40.

We measured our participants’ emotions at the end of each round of decision making by asking them how (1) happy or annoyed they were and (2) how proud or ashamed they were (they could not be both proud and ashamed nor both happy and annoyed). Participants reported their emotions on a scale of 0–10, with 5 being the neutral midpoint between the two emotional extremes (5 = neutral, 4/6 = little or mildly, 3/7 = quite, 2/8 = happy/annoyed/proud/ashamed, 1/9 = very and 0/10 = extremely). The emotions were presented as mutually exclusive, with participants being allowed to report that they were happy, annoyed or neutral and ashamed, proud or neutral.

After the experiment, we asked each participant to complete a questionnaire which (1) included a 10-question personality test (Gosling et al. 2003) that provides a rough measure of five standard personality variables (Agreeableness, Conscientiousness, Emotional stability, Extroversion and Openness), (2) asked their gender and whether they knew about game theory or not and (3) asked them to choose from a list of phrases the one that best described their motivations during the experiment (Making myself the maximum money possible; Making other people the maximum money possible; Making everyone the maximum money possible; Making myself more money than other people; Other), and to choose their most desired outcome from a list of hypothetical outcomes (Everybody makes a maximal and equal amount; You

(a)

Player Name	Contribution (0 – 40)	Player Income =	Credits retained	+ credits returned	= Total credits
Player D	0	Player D =	40	35	75
Player A	10	Player A =	30	35	65
You	20	- For You =	20	35	55
Player C	40	Player C =	0	35	35

This screen lists the decisions of you and the other players in your group (for this round).
Remember the terms Player A, B, C & D are meaningless as you play with different pepople in each round
Your income from your group's contributions and subsequent 'growth' is also shown. The income of the other players is also shown.
Please press the 'Continue' button when you are ready and the experiment will continue.

(b)

Group Name	Contribution (0 – 160)	Group Income =	Credits retained	+ credits returned	= Total credits
group C	140	group C =	20	280	300
Your Group	70	Your Group =	90	140	230
- Your part	20	- For You...	20	35	55
group D	70	group D =	90	140	230
group A	40	group A =	120	80	200

This screen lists the decisions of you, your group and the other group (for this round).
Remember the terms Group A, B, C & D are meaningless as you play with different pepople in each round.
Your income from your group's contributions and subsequent 'growth' is also shown. The income of the other groups is also shown.
Please press the 'Continue' button when you are ready and the experiment will continue.

Figure 1. The different treatments presented to participants. (a) Representation of the screen the participants received in the within-group information treatment. (b) The alternative screen for the among-group information treatment. The black arrows were not part of the display and are for informative purposes here only, to show how the entities were 'ranked' on their final monetary units (from that round) and how this corresponds to that entity's relative contributions.

make the near maximal amount and other players make less than you; You make a medium amount, which helps the other players to make even more; Everybody makes a medium and equal amount; Other).

We used linear mixed models (LMM) to analyse contribution levels, using the session means per round to avoid pseudoreplication from nonindependent participants (Hurlbert 1984), and fitting 'Session ID' as a random effect to account for the repeated measures over time. As the treatment effect was not applied until after the first contributions had been made, we excluded the first time period for each treatment when comparing the mean levels of contributions, but we included the first time period when analysing any changes in contributions over time. We controlled for any temporal autocorrelation within sessions by modelling the repeated measures (rounds within treatments) with a first-order autoregressive covariance structure. When comparing participants' emotional responses we used the individual data and transformed participants' emotional responses and personality scores, which were proportional in nature, with an arcsine square-root transformation.

RESULTS

Overall, the mean level of cooperation was significantly higher when playing the among-group information treatment (33%, mean $\pm$ SD $= 13.2 \pm 5.15$ MU) than in the within-group information treatment (24%, mean $\pm$ SD $= 9.5 \pm 5.11$ MU; LMM: $F_{1,5} = 7.0$, $P = 0.046$). The mean level of cooperation was initially the same for both treatments (LMM: $F_{1,10} = 0.9$, $P = 0.356$), but then declined significantly more slowly in the among-group information treatment (-0.58 MU per round) compared to the within-group information treatment (-1.26 MU per round; LMM: treatment*round: $F_{1,10.4} = 11.7$, $P = 0.006$).

Although the treatment order had no overall effect (LMM: $F_{1,4} = 0.8$, $P = 0.424$) and did not interact with treatment (LMM: treatment*order: $F_{1,4} = 0.2$, $P = 0.666$) there were some differences when the naïve and experienced participants were analysed separately. Whereas the among-group information induced higher overall cooperation levels among naïve participants (LMM: $F_{1,4} = 7.9$, $P = 0.048$; Fig. 2a), there was no overall mean difference between experienced participants (LMM: $F_{1,4} = 0.1$, $P = 0.821$; Fig. 2b). However, this was driven by different starting levels among the experienced participants, and cooperation still declined less rapidly for those receiving the among-group information (LMM: treatment*round, experienced participants only: $F_{1,10.8} = 11.2$, $P = 0.007$; Fig. 2b).

Participants' emotional responses depended on their on-screen positional rankings both as individuals and as groups (Fig. 3). Participants reported: more happiness when either they or their group were ranked higher on the screen (LMM: Rank: $F_{1,1675.0} = 100.1$, $P < 0.001$; Fig. 3a); more annoyance when they or their group were ranked lower (LMM: Rank: $F_{1,1661.2} = 126.5$, $P < 0.001$; Fig. 3b); more feelings of shame when their group was ranked lower, but not when they individually were ranked higher or lower (LMM: Treatment*Rank: $F_{1,1873.1} = 9.2$, $P = 0.002$; Fig. 3c); and more pride when their group was ranked higher (LMM:

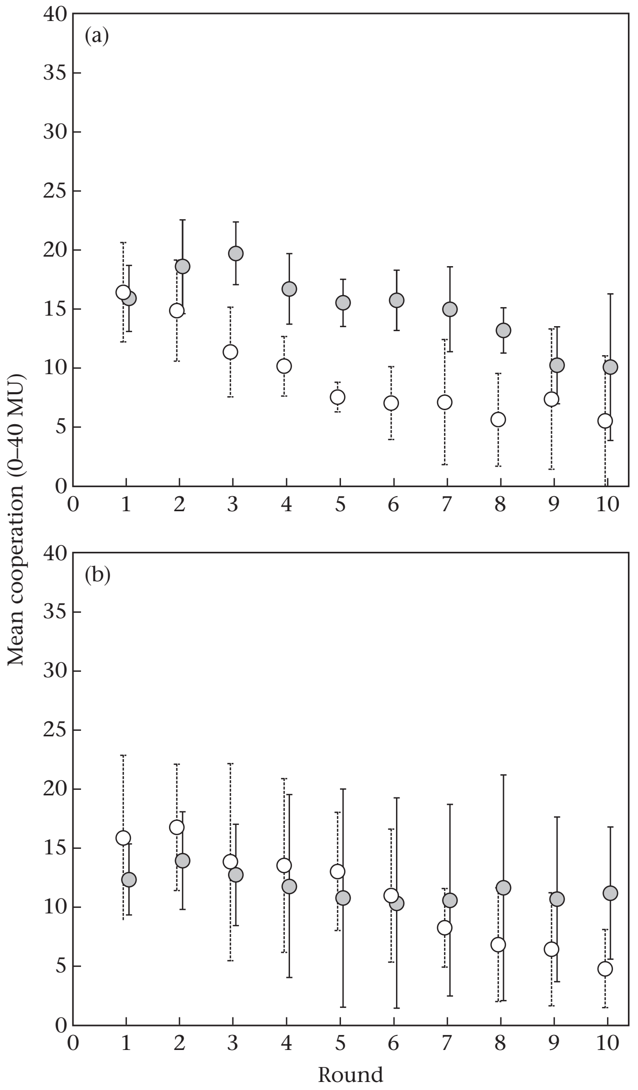

Figure 2. The mean level of cooperation over time for the different public-goods game treatments. In total, six sessions of 16 participants each played the same public-goods game under two treatments that differed only in their information content after each round. In both (a) and (b) the grey/white circles represent the among-group/within-group information treatments, respectively. In (a) the participants were naïve regarding public-goods games; in (b) the same participants from (a) now played again but under the different treatments. Note that in round 1 of both (a) and (b), the participants had not yet been exposed to the corresponding information treatment. Error bars are 95% confidence intervals based upon the session means for each round ($N = 3$).

Treatment*Rank, $F_{1,1825.8} = 21.0$, $P < 0.001$; Fig. 3d), but a U-shaped response to their individual rank, with more pride when they were ranked at either the top (and thus had earned the most), or at the bottom (and thus had contributed the most; LMM: Treatment*Rank^2: $F_{1,1781.0} = 5.0$, $P = 0.025$; Fig. 3d).

Individual differences in cooperation levels did not depend upon gender (LMM: $F_{1,82.9} = 0.1$, $P = 0.912$) nor upon any of the aspects of personality (LMM: Agreeableness: $F_{1,81.2} = 0.04$, $P = 0.837$; Conscientiousness: $F_{1,82.4} = 0.1$, $P = 0.746$; Emotional stability: $F_{1,87.7} = 0.9$, $P = 0.397$; Extroversion: $F_{1,83.4} = 0.01$, $P = 0.937$; Openness: $F_{1,89.5} = 0.6$, $P = 0.434$) or knowledge of game theory (LMM: $F_{1,91.0} = 0.7$, $P = 0.408$) or expressed preferences among the set of hypothetical outcomes (LMM: $F_{1,92.1} = 3.2$, $P = 0.078$). Individuals that indicated that their motivation was 'Making everyone the maximum money possible' ($N = 35$, mean cooperation = 17.0 MU) cooperated more than those that were motivated by either 'Making myself the maximum money possible' ($N = 46$, mean = 7.9 MU) or 'Making myself more money than other people' ($N = 7$, mean = 6.0 MU; LMM: $F_{1,90.0} = 31.8$, $P < 0.001$). However, these motivations did not affect how a participant responded to the change in treatments (LMM: Motivation*Treatment: $F_{1,89} = 0.3$, $P = 0.587$).

DISCUSSION

We found that giving information to individuals about the relative success of their group led to significantly higher levels of cooperation than giving them information about their relative success within their group (Fig. 2). These behavioural responses were linked to how individuals responded emotionally to both their individual rankings and the rankings of their group (Fig. 3). Participants reported more happiness and less annoyance when they, or their group, earned more, more shame and less pride when their group earned less and most pride when they, as individuals, earned either the most or the least (and therefore had contributed the most).

Our result that information about group success led to higher levels of cooperation (Fig. 2) is potentially counterintuitive, given that the monetary payoffs were identical across treatments, and so we should not expect this information to influence the behaviour of rational players. One possible explanation for this is that competition among groups either is, or has been, important in more natural conditions (Bowles 2006, 2009; Choi & Bowles 2007), and so humans have a psychology that is predisposed to respond to cues of group competition. This is because such facultative behaviour would have been advantageous in the evolutionary past (and may still be but this is not necessary), and therefore may still be activated today, even under controlled laboratory conditions and unfavourable payoffs. This possibility is supported by the fact that individual emotions were correlated with group success. Our argument here is analogous to the idea that humans cooperate more in response to images of human eyes, because reputational effects are important in natural conditions (Haley & Fessler 2005; Bateson et al. 2006; Burnham & Hare 2007; Rigdon et al. 2009; Ernest-Jones et al. 2011). Of course a facultative response to group competition, or cues of such, may also increase cooperation via an increase in aggression levels and/or the tendency to reward/punish cooperators/noncooperators (Moreno 2011; Saaksvuori et al. 2011; Gneezy & Fessler 2012).

Mechanistically, we know from the social sciences that experimenters are able to transform participants' 'social identities' by changing emphasis in the instructions about who will benefit from any cooperation (Brewer & Kramer 1986; De Cremer & Van Vugt 1999). We also know that people respond more favourably towards others that can only be conceived as belonging to their same group on a minimal basis (the 'minimal intergroup paradigm'; Tajfel et al. 1971; Tajfel 1982), for example, because they both preferred the same of two similar, abstract paintings, one by Kandinsky and one by Klee (Yamagishi & Kiyonari 2000; Yamagishi et al. 2008). Of course, such transformations of social motives represent proximate, mechanistic, responses and therefore complement, rather than challenge, any ultimate explanation(s) (Mayr 1961; Tinbergen 1963; Scott-Phillips et al. 2011). Future studies should also aim to incorporate how leadership, partner choice and participant asymmetries affect such intra- and intergroup dynamics (King et al. 2009; Dawkins 2010; Baumard et al., in press).

However, another possibility is that because the within-group information treatment emphasized that cooperation is always costly (Fig. 1), it led to individuals learning relatively faster that they should not cooperate (Baron 2001; Kummerli et al. 2010). In

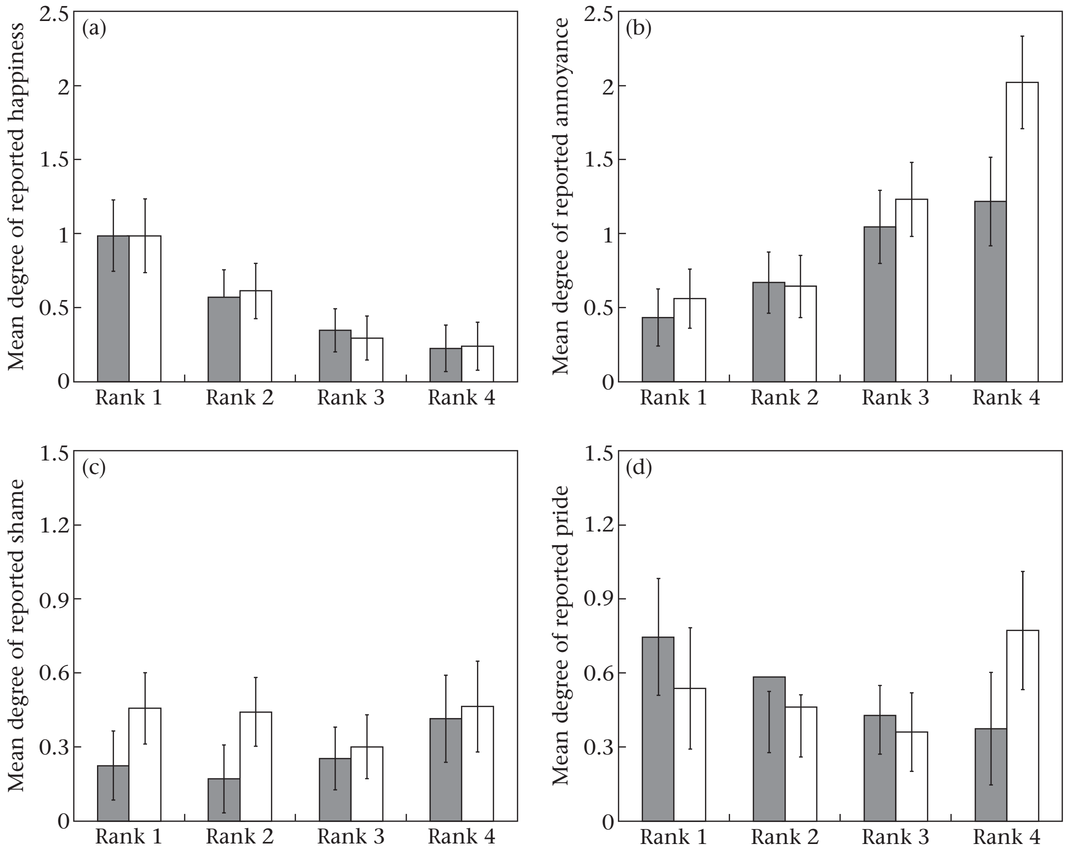

Figure 3. Participants' mean emotional responses to their rankings. After each round of decision making and information feedback, participants were asked to report their (a) Happiness, (b) Annoyance, (c) Shame and (d) Pride, on a scale of 0–5 (0 = neutral). The emotions were presented as mutually exclusive pairings, with participants being allowed to report that they were happy or annoyed and ashamed or proud. Grey/white bars represent among-group/within-group information treatments, respectively. Error bars are 95% confidence intervals based upon the session means for each round ($N = 3$).

contrast, the among-group information treatment emphasized that groups that are more cooperative make more money, and therefore participants may have erroneously concluded that cooperation was directly profitable. This would explain why cooperation appeared initially to increase in the among-group information treatment (Fig. 2a). Alternatively, if we wished to obtain a rational choice explanation then we would have to assume both (1) that the players were conditional cooperators (Fischbacher et al. 2001; Fischbacher & Gachter 2010) and (2) that these players expected greater cooperation from their groupmates in the among-group information treatment (Dufwenberg et al. 2011). However, all these explanations would also need to incorporate the emotional responses.

More generally, our results illustrate the need for caution when interpreting data from economic experiments. It is sometimes assumed that players are rational and fully aware of the extended consequences of their decisions both for themselves and for others, with their decisions revealing their underlying preferences (Kahneman & Sugden 2005). For example, if individuals cooperate more than expected in a game, then this reflects an evolved predisposition to make personal sacrifices for the good of others even when there is no prospect of reciprocity or reputational benefits. However, our results emphasize that we should not expect 'perfect' behaviour, and that factors such as the way in which a game is presented, psychology and learning can interact to influence behaviour (Andreoni 1995; Willinger & Ziegelmeyer 1999; Dufwenberg et al. 2011). Indeed, our results on emotional responses suggest that pride can even lead to divergent strategies whereby individuals behave at the extremes, of either fully cooperating or fully defecting. Consequently, because individuals may make mistakes, or be influenced by factors that the experimenter has not allowed for, this can lead to errors when using data from experimental games to construct utility models (Nowak et al. 2000; Hagen & Hammerstein 2006; West et al. 2011).

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