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Human children but not chimpanzees make irrational decisions driven by social comparison

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Human evolutionary success is often argued to be rooted in specialized social skills and motivations that result in more prosocial, rational and cooperative decisions. One manifestation of human ultra-sociality is the tendency to engage in social comparison. While social comparison studies typically focus on cooperative behaviour and emphasize concern for fairness and equality, here we investigate the competitive dimension of social comparison: a preference for getting more than others, expressed in a willingness to maximize relative payoff at the cost of absolute payoff. Chimpanzees and human children (5–6- and 9–10-year-olds) could decide between an option that maximized their absolute payoff (but put their partner at an advantage) and an option that maximized their relative payoff (but decreased their own and their partner's payoff). Results show that, in contrast to chimpanzees and young children, who consistently selected the rational and payoff-maximizing option, older children paid a cost to reduce their partner's payoff to a level below their own. This finding demonstrates that uniquely human social skills and motivations do not necessarily lead to more prosocial, rational and cooperative decision-making.

1. Introduction

Compared with chimpanzees, our closest and highly social primate relatives, humans exhibit a suite of species-unique socio-cognitive skills and motivations [1]. The evolutionary emergence of these so-called ultra-social tendencies has been linked to the fact that humans live not only in highly complex social groups, like many other animals, but in cultural groups [2–6]. Cultural adaptations—from imitation learning and pedagogical sensitivity to flexible prosociality and fairness-based cooperation—develop early in human ontogeny [7–10]. Across a large variety of domains, the emergence of species-typical social skills and motivations has been shown to make humans more flexible communicators, more proficient social learners, more competent mind readers and more stable cooperators than chimpanzees [11–18].

According to several theorists, social comparison-based fairness represents one especially important psychological mechanism underlying uniquely human patterns of cooperation [19,20]. One key challenge in sustaining cooperation lies in distributing collaboratively acquired resources so that everyone is satisfied and motivated to collaborate in the future [21]. Human sensitivity to fairness is argued to support the resolution of such conflicts of interests by guiding agreed upon distributions [20]. Central principles of fairness, such as equality, make sense only in light of social comparison, which has been singled out as one of the main psychological building blocks supporting a sense of fairness [21,22].

This theoretical perspective is supported by empirical research revealing a potential species difference regarding social comparison-based fairness: while chimpanzees do not seem to compare their payoffs those of others, young children's fairness judgements seem to be mediated by social comparison concerns. In particular, McAuliffe & Blake [23] provided evidence that from about 4 years of age, young children reject unfair distributions in which a partner receives a better reward than themselves (see also [24,25]). Importantly, children's behaviour shows the signature of social comparison: if the partner is absent, rejection rates drop sharply and children are more likely to accept the lower-quality reward [26]. By contrast, although some have taken chimpanzees' refusal of low-quality food in the presence of a partner who received high-quality food as evidence for social comparison [27–30], a number of studies have failed to replicate these results [31–34], and Engelmann *et al.* [34] have recently provided data that point to an alternative explanation for chimpanzee behaviour: the social disappointment hypothesis. According to this hypothesis, chimpanzees' negative emotional reactions to receiving the low-quality reward are grounded in dyadic interpersonal expectations rather than social comparison. It has thus been argued that social comparison-based fairness stabilizes cooperation in humans, but not in chimpanzees [35].

In previous work, social comparison has been framed mostly in a cooperative light, as a psychological mechanism that manifests itself in an aversion to unequal outcomes and a concurrent motivation to equalize outcomes [36]. This is reflected in the fact that all previous experimental paradigms have studied children's behaviour in situations where they can choose between an unequal option and an equal option (for a review, see [37]). However, as pointed out by Sheskin *et al.* [38], when the focus is on the other fundamental dimension of animal sociality—competition—the tendency to compare payoffs likely manifests itself in a preference for maximizing relative payoffs, that is, for getting more than others [37–41], and associated social emotions like envy and *Schadenfreude* [42,43]. Thus, while social comparison can facilitate fair outcomes when cooperative motives in humans are evoked, it can also motivate actions for achieving a relative advantage over others when competitive motives dominate.

This raises the possibility that the human propensity for social comparison might lead human children, but not chimpanzees, to non-rational (i.e. non-payoff-maximizing) courses of action in competitive contexts, though this has yet to be tested empirically. We here define a competitive context as one in which, in contrast to previous studies, participants choose between an option that advantages them and an option that disadvantages them relative to their partner (without an option that equalizes payoffs). In the current study, participants thus made a choice between 'I get more' or 'You get more'. The crux was that the 'You get more' option simultaneously maximized the actor's payoffs, thereby representing the rational decision from a payoff perspective. In the crucial condition, chimpanzees and human children (two age groups: 5–6 years and 9–10 years) decided between two options: 2–1 (actor receives two items and partner receives one) and 3–6 (actor receives three items and partner receives six). We predicted that chimpanzees and young children would choose the payoff-maximizing option whereas older children would select the option that maximized relative payoff, given that previous research has shown that social comparison concerns intensify between kindergarten and fourth grade [44].

We compared subjects' behaviour in this condition with a control condition in which they decided between a 2–5 and 3–6 option. Here we predicted that chimpanzees and children of both age groups would preferentially choose the payoff-maximizing option (3–6) because both options put the partner at the same relative advantage.

2. Material and methods

(a) Child experiment

(i) Participants

We tested 96 Kikuyu children from three rural schools near Nanyuki in Laikipia county in central Kenya. The sample was made up of 48 five- to six-year-old children and 48 nine- to ten-year-old children. Twenty-four subjects of each age group participated in each condition (12 girls, 12 boys). Ten additional children had to be excluded because of experimenter mistake (incorrect reward distribution in the control condition) and one child because she shared her rewards with her partner.

(ii) Materials and design

Participants sat opposite each other at a small table (figure 1; electronic supplementary material). In a between-subjects design, children participated in four trials in one condition (test or control). The procedure consisted of two consecutive steps: a familiarization phase (see electronic supplementary material) and a test phase (see below). All sessions were videotaped for later coding.

(iii) Procedure

For the test phase, participants were paired with new partners (compared with the familiarization phase) to make sure that decisions during the familiarization phase would not influence decisions during the test phase. Once the new partner had sat down on the blue side, the first experimenter (E1) briefly repeated the rules of the game. Then the test phase started. The procedure of one trial was as follows: E1 presented the board with two trays to the subjects (2–1 versus 3–6 in the test condition and 2–5 versus 3–6 in the control condition; locations of allocations on board were counterbalanced), the subject indicated her choice of tray, and then the children placed their respective rewards on their collection sticks. While subjects picked either distribution, E1 lowered her head so as not to influence the subject's decision. Finally, at the end of each trial, E1 asked children how many rewards they had collected in total (if the answer was wrong, E1 asked again or counted out loud if the child could not give the correct answer after the second prompt). This represented the end of the trial. The procedure was repeated four times for a total of four trials. At the end of the four trials, E1 placed the rewards collected by children in envelopes and told them that they would receive their envelope after class.

(iv) Coding and analysis

A research assistant coded from tape whether or not children had selected the distribution that maximized their payoff (3–6). A second research assistant, who was unaware of the study design and hypothesis, independently coded 25% of all trials. Interrater agreement was excellent (Cohen's $\kappa = 1$).

(b) Chimpanzee experiment

(i) Participants

Fifteen chimpanzees (8 females) ranging in age from 8 to 37 years ($M = 20$ years) participated in this study. Six chimpanzees were tested at Sweetwaters Chimpanzee Sanctuary, Kenya, and nine chimpanzees were tested at Wolfgang Köhler Primate Research Center in Leipzig Zoo, Germany, using identical procedures at

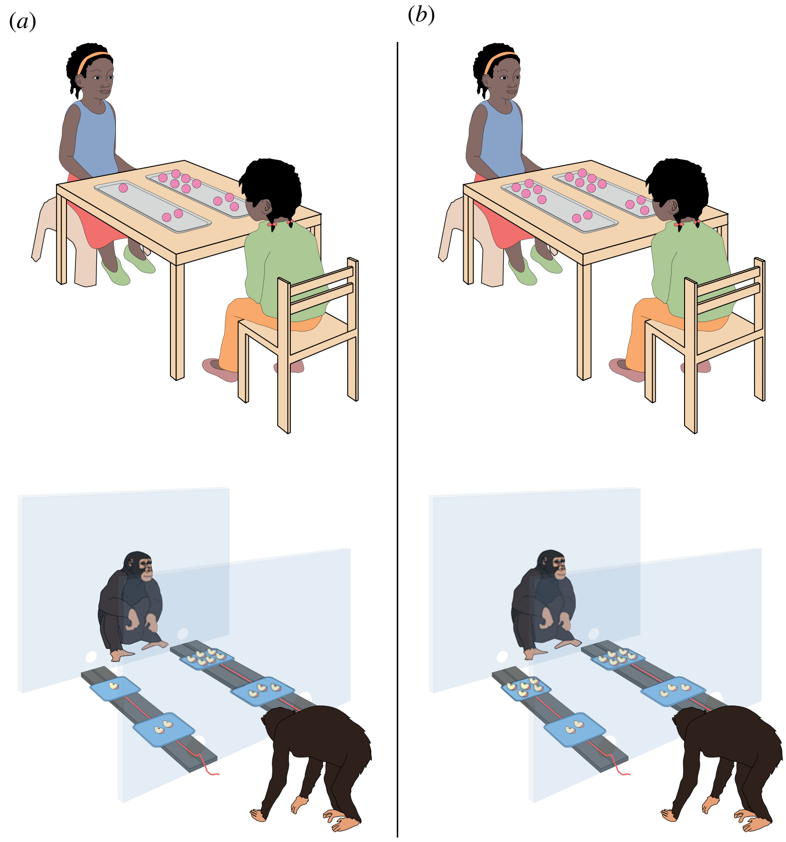

Figure 1. Schematic representation of the set-up and the apparatus in the child and chimpanzee experiments. In each condition, the subject—located in front—could choose one of two options. (*a*) *Test condition*: children and chimpanzees could either select a 2–1 or a 3–6 distribution, depicted on the left side of the image. (*b*) *Control condition*: children and chimpanzees could either select a 2–5 or a 3–6 distribution, depicted on the right side of the image. (Online version in colour.)

the two sites. Each subject was paired with a same-sex partner (see electronic supplementary material).

(ii) Materials and design

Testing took place in two opposing rooms (see electronic supplementary material). In a within-subjects design, chimpanzees participated in two sessions of six trials in each condition. Whether individuals started with the test condition or the control condition was counterbalanced across subjects. The procedure consisted of two consecutive steps: a familiarization phase and a test phase.

(iii) Procedure

During the familiarization phase, subjects were introduced to the apparatus and the contingencies of the task in a series of four steps (see electronic supplementary material). Once subjects had passed this phase, they moved to the test phase. At the beginning of each trial, the partner was located in the partner's room and the subject was located in a room adjacent to the subject's room. Once the first experimenter (E1) had baited the four platforms, a second experimenter opened the door for the subject to enter the subject's room. The subject then had 60 s to choose either option. Once the subject had selected an option by pulling the respective rope, the other rope was removed (either by the first or by a third experimenter). When subject and partner had consumed their rewards, the subject chimpanzee moved back to the first room. E1 then reset the apparatus and the next trial began.

(iv) Coding and analysis

Whether chimpanzees selected the distribution that maximized their payoff (3–6) was coded from tape by the first experimenter. A research assistant, who was unaware of the study design and hypothesis, independently coded 25% of all trials. Interrater agreement was excellent (Cohen's $\kappa = 1$).

3. Results

(a) Children

Figure 2 presents the average selection of the payoff-maximizing option in the four conditions of our 2×2 design. Five- to six-year-old children chose the payoff-maximizing option in 73% of trials in the test condition and in 79.2% in the control condition. Nine- to 10-year-old children selected the payoff-maximizing option in 50% of trials in the test condition and in 84.5% of trials in the control condition.

To test the effects of age and condition (and their potential interaction) on children's likelihood to select the payoff-maximizing option we ran an analysis of variance (ANOVA) with age and condition as between-subject factors. This revealed a significant interaction between age and condition on children's choice ($F_{1,92} = 7.7$, $p = 0.007$). To further investigate the interaction between age and condition we conducted *post hoc* pairwise comparisons. We found a significant difference between the test and control conditions for the 9- to 10-year-old children ($p < 0.001$), showing that older children were significantly less likely to pick the 3–6 option in the test condition—even though this option maximized their absolute payoffs. There was no significant difference between the test and control conditions for the 5- to 6-year-old children ($p = 0.35$). This overall pattern is also reflected when comparing

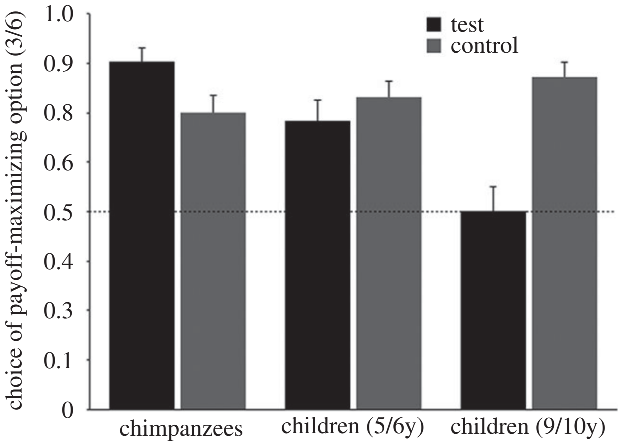

Figure 2. Average choice of payoff-maximizing option (3–6) in *test condition* (where participants made a choice between a 2–1 and a 3–6 payoff distribution) and *control conditions* (choice between a 2–5 and 3–6 payoff distribution) for chimpanzees, younger children and older children. Error bars represent standard error.

children's behaviour with chance. Five- to six-year-old children were significantly more likely than expected by chance to select the payoff-maximizing choice in both conditions, test ($p < 0.001$) and control ($p < 0.001$). Nine- to 10-year-old children, on the other hand, selected the 3–6 option significantly more often than chance only in the control ($p < 0.001$), but not in the test condition ($p = 1$).

(b) Chimpanzees

Chimpanzees selected the payoff-maximizing option (3–6) in 88.3% of trials in the test condition and in 75% of trials in the control condition. In both conditions, chimpanzees pulled the payoff-maximizing option more often than expected by chance (test condition: $p < 0.001$, control condition: $p < 0.001$). We ran a Wilcoxon matched-pairs exact test to determine whether there was a statistical difference between the test and control condition in how often chimpanzees pulled the payoff-maximizing option. The test revealed a significant difference: chimpanzees were more likely to pull the payoff-maximizing choice in the test condition (Mdn = 10.6) than in the control condition (Mdn = 9, $n = 15$, $z = -2.27$, three ties, $p = 0.025$).

4. Discussion

In this study, we investigated the effects of social comparison on children's and chimpanzees' allocation decisions in a competitive context. Participants could decide between an option that maximized their relative payoff compared with a peer—the 'I get more' option—and an option that maximized their absolute payoff but simultaneously put them at a disadvantage compared with a peer—the 'You get more' option. Young children and chimpanzees behaved in a rational manner: they were highly consistent in their choice of the option that maximized absolute payoff. Older children, however, acted in an irrational manner (from a payoff perspective): they paid a cost to be at a relative advantage compared with a peer and thus maximized relative rather than the absolute payoff. Our results bear out the view that the development of novel social motivations does not necessarily result in more rational decision-making [45], but on the contrary, can lead older children to make sub-optimal decisions compared to both younger children and chimpanzees.

While a previous study with participants from an industrialized Western population has shown that children will sometimes prefer a relative advantage to absolute payoffs [38], the current results extend this finding to children from a traditional, small-scale, non-Western group, the Kikuyu. The Kikuyu children in the current sample came from a low socio-economic background and owned no (or very few) personal possessions [46,47]. One might argue that rather than showing a preference for relative advantage, the current results provide evidence that older children are concerned with minimizing inequality. Proportionally speaking, the two options in the test condition, 2–1 and 3–6, are equally fair (0.5), whereas one option in the control condition is more equal (3–6) than the other (2–5). This might explain why older children do not show a preference for either option in the test condition but preferred the 3–6 option in the control condition. To rule out this alternative explanation, we ran an additional control condition for the older children in which they decided between a 2–4 and 3–6 distribution.[1] If children indeed aimed at proportionally equal payoffs rather than maximizing their own payoffs, they also should have been at chance when deciding between these two options. However, older children chose the 3–6 option in 74% of trials, and thus displayed a statistically significant preference ($p < 0.001$) for the option that maximized their payoffs (for details, see electronic supplementary material).

The finding that older children had a stronger preference for relative advantage than younger children is in line with previous research showing that social comparison concerns intensify as children move from early to middle childhood [44,48,49]. At the same time, recent research has shown that inequity aversion increases with age and that children are more likely to select equal rather than unequal distributions as they get older [23,24,37,42,50,51]. One caveat arises regarding the interpretation of our results. The current findings show that older children maximize relative payoff at the cost of absolute payoff when the choice is between a distribution that puts them at a relative advantage and a distribution that puts them at a relative disadvantage. The results do not speak to the relative strength of a preference to get more than others versus a preference for equality. It might well be the case that if we had added a third, equal option to the test condition, older children would have shown a strong preference for this option [24,50,52]. But the question of interest in the current study was not the development of preferences for equal payoff—as in previous studies—but the development of a costly preference to maximize relative payoffs. Future research should investigate how a growing tendency to care about relative payoffs and a concurrent increase in concern for equality can be reconciled. Steinbeis & Singer [42] provide the interesting suggestion that an increase in children's social comparison concerns might in some settings be masked by a simultaneous improvement in emotion regulation, particularly in public settings where exhibiting strong social comparison concerns might come at a reputational cost. This proposal is supported by the finding that reputational concerns increase over childhood [53] and by research showing that children replace overt forms of social comparison with more subtle forms as they grow older [54].

In the present study, chimpanzees, like the younger children, consistently selected the payoff-maximizing course of action. Chimpanzees' pattern of decision-making did not show the signature of social comparison concerns and a preference for a relative over absolute payoffs. This finding is consistent with previous work revealing an absence of social comparison-based fairness concerns in chimpanzees [34]. In fact, in the current study, chimpanzees exhibited a pattern of behaviour opposite to what would be expected by social comparison concerns, as they selected the payoff-maximizing option more often in the test compared with the control condition, a finding that we had not predicted. One potential explanation for this counterintuitive result is that it was more difficult for chimpanzees to decide between the two options in the control condition because their absolute amounts were more similar compared with the test condition. However, step 4 of the familiarization provides conclusive evidence that chimpanzees in the current set-up did not simply go for the option that featured the greatest total reward. In addition, and crucially, chimpanzees showed a highly robust tendency to select the option that maximized their payoffs in both test (88%) and control (75%) conditions.

Taken together, this work presents evidence for the view that chimpanzees are rational-maximizers in the context of resource distributions [33,55]. However, while this idea has been mostly linked to an absence of concerns for fairness and equality in chimpanzees, the current findings highlight that motivations such as social comparison can be a double-edged sword as they influence human behaviour not only in cooperative but also in competitive contexts. That is to say, while social comparison underlies fairness, a hallmark of human social life which gives rise to a concern for equality, at the same time it manifests itself in more negative emotions such as envy and *Schadenfreude*. Chimpanzees might not demonstrate concern for equality, but neither is their behaviour influenced by social comparison's more self-centred expressions. While even children as young as 9 and 10 years of age showed a willingness to reduce their own and their partner's payoff simply in order to come out on top, chimpanzees' decisions—in terms of their outcome—maximized both their own and their partner's payoffs, dispelling the notion that more sociality is always associated with more prosociality.

Ethics. Chimpanzee research was performed in accordance with the recommendations of the Weatherall report (see electronic supplementary material). Informed written consent was obtained from the school guardians of the children who participated in this study.

Data accessibility. Data associated with this manuscript can be accessed as part of the electronic supplementary material.

Authors' contributions. E.H., L.M.H., H.Z. and J.M.E. designed the study, analysed the data and wrote the manuscript. L.M.H. and H.Z. conducted the study.

Competing interests. The authors have no competing interests.

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Endnote

[1]We thank an anonymous reviewer for suggesting this additional control condition.

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