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Economic trust in young children

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Mutually beneficial interactions often require trust that others will reciprocate. Such interpersonal trust is foundational to evolutionarily unique aspects of human social behaviour, such as economic exchange. In adults, interpersonal trust is often assessed using the 'trust game', in which a lender invests resources in a trustee who may or may not repay the loan. This game captures two crucial elements of economic exchange: the potential for greater mutual benefits by trusting in others, and the moral hazard that others may betray that trust. While adults across cultures can trust others, little is known about the developmental origins of this crucial cooperative ability. We developed the first version of the trust game for use with young children that addresses these two components of trust. Across three experiments, we demonstrate that 4- and 6-year-olds recognize opportunities to invest in others, sharing more when reciprocation is possible than in a context measuring pure generosity. Yet, children become better with age at investing in trustworthy over untrustworthy partners, indicating that this cooperative skill emerges later in ontogeny. Together, our results indicate that young children can engage in complex economic exchanges involving judgements about interpersonal trust and show increasing sensitivity to appropriate partners over development.

1. Introduction

Mutually beneficial interactions often require trust that others will reciprocate positive interactions [1]. Such interpersonal trust is an important psychological foundation for unique aspects of human sociality, such as economic exchange and political interactions [2,3]. For example, market transactions cannot occur in the absence of trust between partners [4] and human societies with higher levels of trust are thought to exhibit higher levels of economic growth [5,6]. Experimental evidence further indicates that variation in interpersonal trust predicts levels of cooperation across individuals and groups [7,8]. Yet, trusting others also imposes significant risks [9,10]. In particular, economic exchange can induce a 'moral hazard' when there is no guarantee that social partners will return an investment [11,12]. Despite this risk of betrayal, adults tend to trust others to some degree [13]. Thus, addressing why and how humans are able to overcome the risk posed by acts of interpersonal trust is key for understanding the evolutionary origins of human cooperation [14] and human 'ultra-sociality' more generally.

In adults, economic trust is often measured using the 'trust game' (also called an 'investment game'; [3,15]), a standardized economic exchange with two sequential but interdependent components. First, an investor is endowed with money and decides whether to invest some portion in a trustee. Any money sent to the trustee is increased (typically multiplied by a factor of three) such that the 'loan' leads to larger returns. However, the trustee can then decide to share some of these returns with the investor or retain it in its entirety. Thus, if the investor initially trusts their partner to reciprocate, both players can potentially gain, but there is also the risk that the trustee could betray this trust. While standard economic theories of rationality predict that neither player should send any money to their partner, adults across diverse cultures tend to trust others and reciprocate trust to some degree [1,7,8,13].

The trust game therefore captures the critical components of economic exchange in the absence of contractual enforcement. First, interpersonal trust in others' reciprocity is distinct from pure generosity: adults share more with partners in the trust game than in a dictator game in which there is no opportunity for reciprocation [16,17]. Second, reputation-building can occur when actors have repeated interactions: both direct knowledge of a partner's past actions and indirect third-party knowledge, or 'reputation', can facilitate more trusting behaviour [11,18,19]. This propensity to trust others appears to be either unique to or especially exaggerated in humans, as other animals do not show such robust tendencies for trust when facing a risk of betrayal [20–22] and exhibit limits on their reciprocal behaviour more generally [23,24]. Therefore, engaging in acts of trust and identifying trustworthy exchange partners based on their social history can help overcome the moral hazard problem posed by economic exchange and allow humans to engage in new forms of cooperation.

What psychological mechanisms allow our species to engage in interpersonal trust? Developmental studies of young children can pinpoint the traits that decision-makers must possess to engage in these kinds of social interactions, in the absence of direct experience with economic exchange and with less exposure to culture-specific norms of cooperation. However, prior research on economic trust has primarily focused on trust behaviours in adults [7,8,13,25,26]. Slightly modified paradigms from adults implemented with children have demonstrated that trust is initially low in school-aged children and increases through adolescence [27–29]. Given the complexity of these interactions, however, children's relatively low levels of trust may also reflect a lack of task comprehension, or tasks may be too abstract to elicit relevant responses from children [30]. Only two studies have tested aspects of trust in children under 8 years of age. In one [31], 5- to 10-year-olds played a computer-based reciprocity game in which they could share tokens with adult partners that differed in physical appearance or were described as fair. However, this set-up did not distinguish between economic trust versus generosity regardless of opportunities for reciprocation, a key issue in adult work [16,17]. Another study [32] examined how children aged 4–11 years allocated toys to an (absent) partner who could reciprocate at a later time, and found that children invested regardless of partners' temptation to cheat—possibly due to lack of comprehension of the interaction. Other work on resource sharing in young children has focused on generosity [33,34] or simple reciprocity [35–38], without the crucial aspects of economic exchange in the trust game where players engage in sequential but mutually interdependent decisions involving investment. Thus, it is currently unclear if young children are able to engage in acts of economic trust or distinguish appropriate exchange partners like adults.

One hypothesis is that adult-like forms of trust are in fact absent in young children, as suggested by prior developmental comparisons [27–29]. Acts of interpersonal trust can require complex reasoning about the future actions of the exchange partner, to assess the likelihood that this risky act is being repaid by the partner [26]. Thus, trust might be challenging for younger children, as their ability to think about the future only emerges in middle childhood [39]. For example, while 3-year-old children can engage in some forms of 'retrospective' reciprocation where they track and preferentially share with others who were previously prosocial [35,38], it is only by around 4–5 years of age that children can engage in 'prospective' reciprocity by looking ahead and making inferences about whether someone will act reciprocally towards them in the future [36]. Children may also be limited in their abilities to engage in effective cooperative exchanges because doing so effectively requires attending to others' behavioural signals of trustworthiness [16,17]. Indeed, a crucial stabilizing mechanism for the evolutionary emergence of human cooperation is an ability to track others' behaviour and detect cheaters or free-riders [40,41]. However, young children appear relatively insensitive to reputation information [42] and sometimes do not even act differently towards more or less cooperative individuals [38,43].

Alternatively, young children may be able to engage in some components of economic trust, and developmental comparisons can therefore help disentangle components of trust that are intertwined in adult behaviour but dissociable in children. One hypothesis for developmental change in cooperative behaviour, stemming from a theoretical distinction in biology [44], is that psychological abilities to distribute benefits and protect against free-riders are distinct from earlier-emerging abilities to generate benefits through cooperation [45]. In this view, core capacities for cooperation, including sharing and helping, emerge during the second year of life and may be fairly similar across cultures [46,47]. However, capacities for reciprocation, reputation scoring and adherence to fairness norms—all crucial for sustaining and enforcing cooperation in adults—guide children's behaviour only later in childhood [38,42,43,45] and may be more sensitive to local social norms [48]. Thus, the development of cooperation may involve an ontogenetic shift from a more naive presumption that social partners act in good faith to more selective decision-making that tailors cooperation to specific partners to avoid free-riding. Understanding when children begin to exhibit these different components of trust, and the kinds of experiences needed to do so, can help unravel the origins of human-specific forms of cooperation.

In the current studies, we examined if young children can make trust-based investment decisions and account for the trustworthiness of their interaction partners. We developed a novel trust game with real incentives where a child 'lender' could choose to invest in an interactive partner 'trustee', who may or may not reciprocate. We created a physical instantiation of these components to make the game child-friendly, and used real incentives (tokens) that children could accumulate to acquire attractive toys (figure 1). On each trial, the child was endowed with a token and faced a choice between placing it in their personal 'bank' or using it to complete an array of tokens in a tray. If the child completed an array, she could push it to a trustee, who then decided how to allocate the tokens; incomplete trays were physically blocked. Children played with an interactive partner: a toddler-sized puppet designed to simulate a same-aged partner (rather than an adult whose authority may drive compliance), following well-validated developmental methods [49,50]. This game therefore comprised all of the crucial elements of the adult trust game: children made an investment decision about real incentives; the investment was increased (by a multiple of 4); and the trustee could decide whether to reciprocate that trust.

In study 1, we first confirmed that the youngest children in our sample understood the rules of this complex game. In study 2, we then examined whether 4- and 6-year-olds

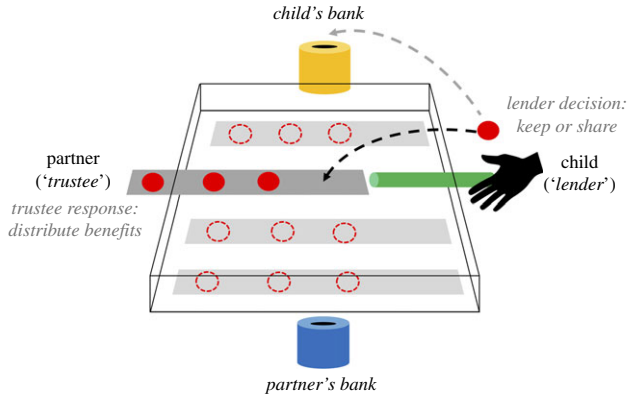

Figure 1. Set-up for economic trust task. The apparatus was a large box with a transparent Plexiglass cover and contained four trays, each with four coin-compartments. On a given trial, only one tray was visible; the rest were covered by a lid. The child (in the role of the 'lender') could insert tokens through a slot above each tray and use a stick to push the tray through the apparatus to the other side. On each trial, the child could first decide to either keep a token (by placing it in their own bank) or invest in their partner by placing the token on a partial array of three tokens. Completed trays of four tokens could then be pushed over to the 'trustee'. Investment in the partner therefore increased the total amount of tokens in play on that trial, but as trustee partners then chose how to distribute tokens they received, the child might end up with nothing. (Online version in colour.)

shared more with partners when reciprocation was possible. Finally, in study 3, we examined whether children preferentially shared with trustworthy over untrustworthy partners. We examined 4- and 6-year-olds because this is the age at which children are first able to think about future actions [39]. Across studies, we tested (i) whether children strategically shared more when this investment could pay off; (ii) whether these preferences changed with age; and (iii) how much experience children needed to decide to invest in a given opportunity for social exchange.

2. Study 1: understanding exchange interactions

Study 1 aimed to ensure that the youngest children could understand the rules of this complex social interaction. Four-year-olds played a non-social game, acting in both roles across a two-step sequence mirroring the social interaction used in subsequent studies. Children could decide whether to place tokens in the apparatus when they were able to retrieve rewards on the other side (*Access condition*) versus when they were physically blocked (*No Access condition*).

(a) Methods

(i) Participants

We tested $N = 16$ 4-year-olds, with equal numbers of boys and girls at each age from a medium-sized city in the USA.

(ii) Apparatus demonstration and comprehension checks

An experimenter E1 (female) first introduced the tokens (poker chips, referred to as 'coins') and explained that they could later be traded for prizes (see electronic supplementary material, for details). During an *apparatus demonstration*, children learned that if the gate was closed, they could access their own bank (a glass mason jar with a slot in the lid), but not move to the other side of the table (see electronic supplementary material, figures S1 and S2). If the gate was open, they could access both their bank and the other side. In subsequent *comprehension checks*, we tested whether children would place their token onto a tray that already had three tokens on it (and thus could be pushed through) versus when the tray had only one token (placing the token here was therefore ineffective as it did not complete the tray). Children completed six comprehension trials where they had access to both sides of the table (see electronic supplementary material).

(iii) Test conditions

Each child was tested in eight trials per condition for both the *Access condition* and the *No Access condition*, administered in two blocks of four trials per condition. We alternated between conditions with the order counterbalanced between subjects.

(iv) Exposure phase

Children experienced two exposure trials per condition prior to the test, and two more trials per condition in the middle of the session as reminders. The trays were already filled with four tokens, so the child only had to push them to the other side with the stick.

(v) Test phase

In the *Access condition*, the gate to the other side of the apparatus was open, so that children could retrieve tokens when pushed to the other side. In the *No Access condition*, the gate was closed and hence, children were not able to access the tokens from the trays. All four trays were initially set up with three tokens; only the tray in use on a given trial was accessible and the rest were covered with lids. In each trial, the child received a token and could decide to place it in her bank or complete a tray. The child played four consecutive trials in one condition and then trays were reset for another trial block in the other condition.

(vi) Coding and reliability

Sessions were coded live. A rater blind to condition and hypotheses also coded 25% of choices from videos, with perfect interrater reliability for all three studies.

(b) Results and discussion

We found that 4-year-olds exhibited above-chance performance on comprehension questions concerning how the apparatus functioned (chance = 50%; mean correct = 69.8%, 95% CI = [55.2, 84.4%], one-sample *t*-test: $t_{15} = 2.90$, $p < 0.05$; see electronic supplementary material, figure S3). They were also more likely to put their tokens on the tray if they could subsequently access the other side (*Access* mean = 83.6%, *No Access* mean = 56.3%, 95% CI for the mean difference = [6.2, 48.4%], paired-samples *t*-test: $t_{15} = 2.76$, $p < 0.05$). Trial-by-trial responses were analysed using generalized linear mixed models (GLMMs) implemented in R. Across all studies, models always included random *subject* intercepts (to account for repeated measures), *trial number* (within condition) and an individual's average performance on *comprehension check* questions to account for any role of variation in task understanding (see electronic

supplementary material, for details of statistical analysis). This confirmed that including condition improved model fit (LRT: $\chi^2 = 34.54$, d.f. = 1, $p < 0.0001$): children placed their token in the apparatus more often when they had access to the other side. Four-year-olds also already showed this preference on their first trial in each condition (*Access condition*: 93.8% of children placed a token into the apparatus; *No Access condition*: 68.8% did so). This indicates that the youngest children tested in subsequent studies quickly understood the crucial components of the trust game and could modulate their resource decisions appropriately.

3. Study 2: investment versus dictator game

In study 2, we then examined whether young children could exhibit trust by investing in a partner with the possibility of reciprocation, compared to a structurally identical situation that measured pure generosity. In the *Investment condition*, the trustee could decide to allocate any tokens they received between themself and the child. Thus, children could give up rewards in their possession and either be reciprocated or risk getting nothing (in fact, the partner split the profits equally). In the *Dictator condition*, a barrier physically blocked the trustee's access to the child's bank, such that any tokens shared by the child represented pure generosity without the possibility of reciprocation. We predicted that young children would be able to identify opportunities for trust, defined as sharing more in the investment than the dictator condition.

(a) Methods

(i) Participants

We tested a new sample of $N = 32$ children (16 4-year-olds and 16 6-year-olds) with equal numbers of boys and girls from the same population as study 1.

(ii) Test conditions and comprehension checks

We used the same basic set-up as study 1. Each child was tested in both the *Investment condition* and the *Dictator condition*, administered in two blocks of four trials per condition. We alternated between conditions, with the order counterbalanced between subjects; each child completed eight trials per condition.

(iii) Puppet introduction

The puppeteer (E2) sat on the same side as the puppet, opposite the child, while handling the puppet. E1 introduced the puppet partner by name (Anna) and stated that she (the puppet) would play the coin game with the child (see electronic supplementary material, for details). Players collected tokens by inserting them into their respective banks.

(iv) Exposure phase

Children experienced two trials per condition before test trials and two more trials per condition in the middle of the session as reminders. Here, E1 explained that the child (player A, the 'lender') and the puppet (player B, the 'trustee') would stay on their respective side of the table; a barrier was set up to block their access. All four trays were already completed with tokens, so the child could just push the tray through without needing to decide whether to invest a token. The partner then retrieved the tray and distributed the tokens. In the first two trials, the partner had access to her own bank and the child's bank (the *Investment condition* set-up), and always split the tokens evenly. In the last two trials, E1 placed a box over the child's bank, blocking the partner's access to it (the *Dictator condition* set-up). Thus, the partner had no choice but to place all four tokens into her own bank (see electronic supplementary material, for a detailed script of the partner's behaviour).

(v) Test phase

In each trial, the child received a token and could decide to place it in her own bank, or complete one of the trays. In the *Investment condition*, the partner divided tokens she received equally between her own bank and the child's bank. In the *Dictator condition*, the box blocked the partner's access to the child's bank, so the partner always kept all four tokens.

(b) Results and discussion

We found that both age groups shared more often in the Investment condition than in the Dictator condition (*4-year-olds:* Investment mean = 61.7%, Dictator mean = 40.6%, 95% CI for the mean difference = [9.5, 32.7], $t_{15} = 3.88$, $p < 0.005$; *6-year-olds:* Investment mean = 69.5%, Dictator mean = 25.8%, 95% CI for the mean difference = [21.5, 66.0], $t_{15} = 4.18$, $p < 0.001$; figure 2*a*). To analyse trial-by-trial binary responses, we again implemented GLMMs, and compared model fit using likelihood ratio tests. We found that including *condition* in a second model improved model fit (LRT: $\chi^2 = 65.55$, d.f. = 1, $p < 0.0001$): children shared more in the Investment condition when reciprocity was possible. We then added *age group*, which did not further improve fit (LRT: $\chi^2 = 0.57$, d.f. = 1, $p > 0.45$, n.s.), indicating similar overall propensity to share in both cohorts. Finally, we added the interaction between *age* and *condition*, which improved fit (LRT: $\chi^2 = 6.87$, d.f. = 1, $p < 0.01$; see electronic supplementary material, for parameters). Post hoc comparisons showed that both groups shared more in the Investment condition, but this effect was greater for older children ($p < 0.01$ for significant comparisons). Importantly, both ages showed above-chance performance on comprehension checks (*4-year-olds* = 69.8% correct, 95% CI = [59.0, 80.7], one-sample *t*-test: $t_{15} = 3.89$, $p < 0.005$; *6-year-olds* = 84.4% correct, 95% CI = [72.0, 97.0], one-sample *t*-test: $t_{15} = 5.94$, $p < 0.0001$), and analyses of sharing behaviours further controlled for any variation in comprehension.

We then examined children's first-trial responses: an index of their initial intuitions about trust and generosity (figure 2*b*). In fact, both age groups shared more in the Investment than Dictator condition on their first test trial (*4-year-olds:* Investment mean = 50.0%, Dictator mean = 25.0%; *6-year-olds:* Investment mean = 56.3%, Dictator mean = 12.5%). We fit GLMM models for first-trial responses using the same basic procedure described for the full dataset, and found similar results: adding *condition* improved model fit (LRT: $\chi^2 = 8.51$, d.f. = 1, $p < 0.005$); and there was no improvement by adding *age* (LRT: $\chi^2 = 0.24$, d.f. = 1, $p > 0.62$, n.s.) or the *age by condition* interaction (LRT: $\chi^2 = 0.89$, d.f. = 1, $p > 0.34$, n.s.). Thus, even the youngest children in our sample were already sensitive to whether their sharing behaviour could be reciprocated with minimal experience. To further assess the extent to which learning shaped children's sharing, we examined trial-by-trial learning (figure 2*c*,*d*). Results showed that both age groups exhibited consistent preferences in both conditions: including condition improved fit for both the

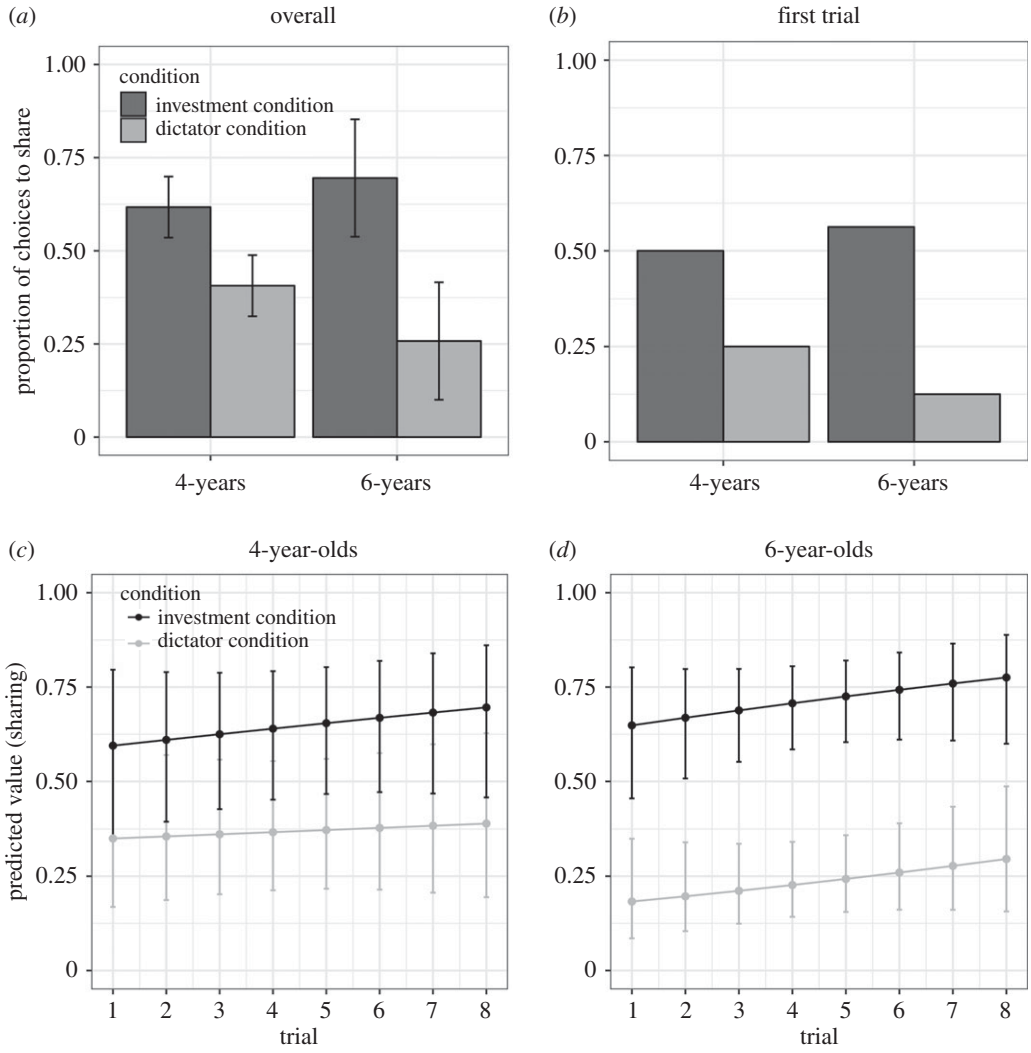

Figure 2. Sharing decisions in the Investment versus Dictator condition (study 2). (*a*) Children's mean decisions to share a token across all trials; error bars reflect within-subject 95% CIs. (*b*) The proportion of children who shared on their first trial for each condition. (*c*) Estimated values and 95% CIs for sharing across trials by condition for 4-year-olds and (*d*) for 6-year-olds; estimates are derived from mixed models also accounting for subject identity and pre-test comprehension responses.

4-year-olds and 6-year-olds, but there was no significant effect of *trial* nor a *trial by condition* interaction for either age group (see electronic supplementary material, for details). Thus, both age groups shared more in the Investment than the Dictator condition on their first trial and showed constant preferences over time.

4. Study 3: trustworthy versus untrustworthy partners

In study 3, children played the trust game with a *Trustworthy partner* who always split rewards equally if the child invested, and an *Untrustworthy partner* who always kept the child's full investment. We assessed at what age children could track the social history of potential partners and adjust their sharing by investing more in the trustworthy versus untrustworthy partner.

(a) Methods

(i) Participants and basic set-up

We tested a new sample of $N = 32$ children (16 4-year-olds and 16 6-year-olds) with equal numbers of boys and girls from the same population as the prior studies.

(ii) Test conditions and comprehension checks

We used the same basic set-up, procedure and comprehension checks as study 2. Each child was tested in both the *Trustworthy partner* and the *Untrustworthy partner* conditions (eight trials per condition), following the same general counterbalancing procedures as study 2 (see electronic supplementary material).

(iii) Exposure phase

We used the same procedure for exposure trials as in study 2, but here children experienced both the *Trustworthy* and *Untrustworthy* partners. The *Trustworthy partner* always split resources in half, while the *Untrustworthy partner* took them all. In exposure trials, children pushed trays that were pre-filled with four tokens and could experience how each partner responded (see electronic supplementary material, for detailed script of the partner's behaviour).

(iv) Test phase

The child played four consecutive trials with one partner, and then the trays were reset for a block with the other partner (condition order counterbalanced across subjects).

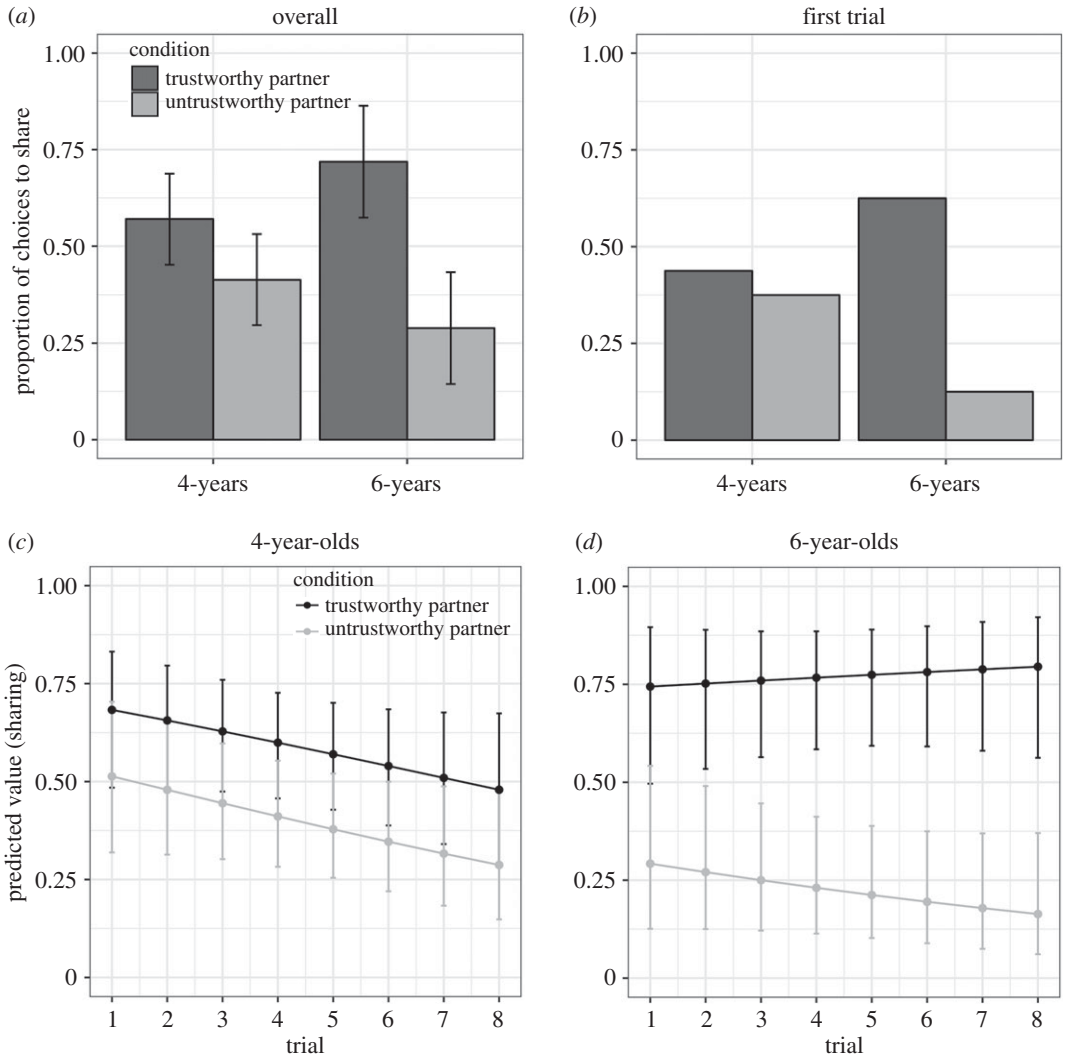

Figure 3. Sharing decisions in response to Trustworthy versus Untrustworthy partners (study 3). (*a*) Children's mean decisions to share a token across all trials; error bars reflect within-subject 95% CIs. (*b*) The proportion of children who shared on their first trial for each condition. (*c*) Estimated values and 95% CIs for sharing across trials by condition for 4-year-olds and (*d*) for 6-year-olds; estimates are derived from mixed models also accounting for subject identity and pre- and post-test comprehension responses.

(b) Results and discussion

We found that older children were more likely to share with the trustworthy partner (figure 3*a*; *6-year-olds*: Trustworthy mean = 71.9% of trials, Untrustworthy mean = 28.9%, 95% CI for the mean difference = [22.5, 63.5], $t_{15} = 4.47$, $p < 0.0005$). However, younger children showed only a trend to differentiate the partners (*4-year-olds*: Trustworthy mean = 57.0%, Untrustworthy = 41.4%; 95% CI for the mean difference = [−0.1, 32.2], $t_{15} = 2.01$, $p = 0.063$). To analyse trial-by-trial responses, we used the same basic procedure described for studies 1 and 2; models for study 3 also accounted for a post-test check concerning correct identification of the partners. We found that including *condition* (Trustworthy versus Untrustworthy partner) improved model fit (LRT: $\chi^2 = 54.80$, d.f. = 1, $p < 0.0001$), but *age group* did not (LRT: $\chi^2 = 0.21$, d.f. = 1, $p > 0.64$, n.s.). Finally, in the full model, we included the interaction between *age* and *condition*, which did improve fit (LRT: $\chi^2 = 13.73$, d.f. = 1, $p < 0.0005$; see electronic supplementary material, for parameters from the full model). Post hoc comparisons indicated that both age groups shared more with the trustworthy partner but that this condition effect was greater for older children ($p < 0.05$ for significant comparisons).

We then examined children's first-trial responses towards the partners (figure 3*b*). Whereas older children shared more with the trustworthy partner on their first test trial (*6-year-olds:* Trustworthy mean = 62.5% of trials, Untrustworthy mean = 12.5%), younger children did not (*4-year-olds:* Trustworthy mean = 43.8% of trials, Untrustworthy mean = 37.5%). GLMM models of first-trial responses showed that including *condition* improved fit (LRT: $\chi^2 = 7.75$, d.f. = 1, $p < 0.01$), as did the interaction term of *age* and *condition* (LRT: $\chi^2 = 11.60$, d.f. = 1, $p < 0.0005$). Post hoc comparisons showed that 6-year-olds shared more with the Trustworthy partner than the Untrustworthy partner on the first trial ($p < 0.005$), whereas 4-year-olds shared equally. Moreover, 6-year-olds shared more with the Trustworthy partner than did 4-year-olds with either partner ($p < 0.001$). Thus, older children quickly distinguished between the trustworthiness of potential partners, but younger children did not. An analysis of trial-by-trial learning also indicated different patterns by age group (see figure 3*c*,*d*; electronic supplementary material, for details). Older children showed constant preferences between partners, adjusting their cooperation by consistently investing selectively in the trustworthy partner and avoiding exploitation. In contrast, younger children exhibited a

significant decline in sharing over trials with both partners. A potential explanation is that younger children became generally more sceptical after experiencing untrustworthy behaviours, but were unable to correctly calibrate their sharing in response to individual partners' behaviours.

Despite these differences in their sharing behaviour, both age groups exhibited similarly high levels of understanding on comprehension checks, correctly answering pre-test comprehension questions about the apparatus (*4-year-olds* = 72.9% correct, 95% CI = [61.3, 84.6], one-sample *t*-test: $t_{15} = 4.21$, $p < 0.001$; *6-year-olds* = 85.4% correct, 95% CI = [74.7, 96.0], one-sample *t*-test: $t_{15} = 7.06$, $p < 0.0001$), with no difference between the two age groups (paired-sample *t*-test: $t_{30} = -1.68$, $p > 0.10$, n.s.). Moreover, both age groups could accurately identify the untrustworthy partner, with no difference between groups (*4-year-olds*: 87.5% answered correctly; *6-year-olds*: 93.8% answered correctly; $\chi^2 = 0.03$, d.f. = 1, $p = 0.55$, n.s.). Overall, this pattern of results indicates that younger children understood the set-up and detected that their sharing was not reciprocated by the untrustworthy partner, but did not adjust their responses like the older children.

5. General discussion

These three studies examined the ontogeny of economic trust. Study 1 showed that young children could understand the interdependent decisions of the lender and trustee, a crucial consideration given the complexity of the trust game [30]. Study 2 provides the first demonstration that young children can engage in acts of trust despite risk of betrayal. In contrast to prior work suggesting low rates of trust in children tested on adult economic games [27–29], we found that children shared more in an investment game compared to a dictator game, even with little experience, when they engaged in a child-friendly interaction. Finally, study 3 showed that 6-year-olds quickly discriminated between a trustworthy and an untrustworthy partner, whereas 4-year-olds initially shared equally with both partners and showed a general decline in overall sharing over interactions—perhaps reflecting an inability to correctly adjust their behaviour in response to untrustworthiness. This suggests that the ability to detect opportunities to trust others emerges earlier in development, whereas successfully tracking others' past cooperative actions—crucial for cheater detection and indirect reciprocity [41]—requires more experience. Overall, these results indicate that even young children can detect and strategically leverage opportunities for reciprocation, but they trust more indiscriminately, whereas older children can better direct their sharing towards trustworthy exchange partners.

The ability to direct cooperative actions towards appropriate partners is a crucial pre-condition for sustained cooperation, given that if actors do not cooperate selectively with those who reciprocate, then they are likely to be exploited by free-riders [40,45]. Our work shows that this kind of partner selection is challenging for younger children, and may therefore be a major evolutionary constraint on the evolution of trust: whereas the youngest children tested here could rapidly detect opportunities for future reciprocal interactions, they were less successful at calibrating their behaviour to partners that responded differently to their trust. What drives this shift in children's ability to flexibly adjust to different partners? One crucial social–cognitive ability for reciprocity is the detection of liars and cheaters. Notably, younger children have difficulty determining when others are lying to them, and may be deceived repeatedly even when these informants are explicitly flagged as liars [51,52]. It is only around 4–5 years of age that children begin to disregard information from dishonest informants. The fact that younger children can engage in trust but seem to have a naive presumption that social partners act in good faith, whereas older children engage in more selective cooperation, suggests that these two crucial components of adult trust can be dissociated across human ontogeny. This supports the hypothesis that psychological abilities to protect against free-riders are distinct from (and later-emerging than) abilities to generate benefits through cooperation [44,45]. Given that early-emerging cooperative capacities seem to be more universal [47], whereas later-emerging cooperative abilities are more sensitive to social norms [48], future work should therefore examine whether the ability to identify opportunities for trust emerges on a consistent time course across cultures, while the development of skills for tracking and responding to untrustworthy partners may vary more according to local cultural context.

Why might children be seemingly credulous towards social partners, regardless of their actual behaviour, earlier in development? One possibility is that younger children do not exhibit these skills because they do not yet need them. From an evolutionary perspective, young children are primarily surrounded by close kin and caregivers, and they may not be under the same pressure to reliably discriminate different kinds of partners in the same way as older children, who face choices among a wider range of potential social partners [53]. In this sense, patterns of cognitive development may track evolutionarily relevant life-history shifts, such that children acquire specific skills timed to new situations or affordances across the life-course [54,55]. Alternatively, young children may be expressing a true bias towards making cooperative first moves, sometimes termed a 'nice' strategy. Nice strategies are defined as strategies that do not defect first, and theoretical models show that such 'niceness' tends to launch a bout of reciprocal interactions [56]. Similarly, empirical studies show that individuals who utilize a nice strategy, and who therefore experience mutual cooperation with an initial partner, are more likely to continue reaping the benefits of cooperation with an initial partner, are more likely continue the nice strategy and continue reaping the benefits of cooperation [57]. Thus, a more 'trusting' orientation early in development might actually serve to bootstrap cooperation and foster the formation of long-term reciprocal relationships.

Indeed, a propensity to trust others in such contexts appears to be either unique to or especially exaggerated in humans, as current comparative evidence suggests that other animals do not show similar tendencies. The only evidence for non-human trust in reciprocity comes from low-cost interactions where the partner's temptation to engage in betrayal is reduced [20–22]. More broadly, there is surprisingly little empirical evidence for any sort of reciprocal interactions in non-human animals, despite theoretical proposals suggesting that reciprocity should be common in nature [23,24]. For example, while humans routinely use reciprocation in the context of food sharing, most other primates do not [22]. Chimpanzees (*Pan troglodytes*), one of our closest primate relatives, exhibit some forms of reciprocal interactions in

natural interactions like grooming, but do not exhibit robust contingent reciprocity involving reasoning about costs and benefits [23,24,58,59]. This stands in contrast to chimpanzees' sophistication when it comes to mutualistic forms of cooperation [45]. Moreover, the evidence that non-humans track the past behaviour of others and use this information for their own social decision-making, or try to manage their own reputation, is also surprisingly sparse [60–62]. The fact that adults across cultures [1,7,8,13] as well young children in the current work trust in others' reciprocity, whereas other animals do not, suggests that there has been a major evolutionary shift in how humans engage in cooperative acts.

In summary, the ability to engage in acts of trust underpin human-specific forms of economic exchange. While many types of economic behaviour depend on general cognitive abilities, such as abstract reasoning or use of symbolic markers like money to track debts and credits, economic exchange cannot emerge in the absence of social trust that others will reciprocate [4]. As such, understanding the roots of economic trust is crucial for understanding the emergence of human-specific forms of cooperation more generally. Our work demonstrates that the core components of this fundamental human ability emerge early in development, as even young children can identify opportunities to trust others in situations entailing a risk of betrayal and are beginning to discriminate and direct cooperation towards trustworthy partners. These abilities set the stage for more complex economic interactions that underpin human social life.

Ethics. All behavioural studies were approved by Harvard University's Institutional Review Board (#F18470). Parents consented on behalf of their children and children verbally assented to participate in the study.

Data accessibility. All data from these studies are available in the Dryad Digital Repository: https://doi.org/10.5061/dryad.3r0s513 [63].

Authors' contributions. A.G.R. and F.W. designed the studies, N.B. and K.P. collected the data; A.G.R. analysed the data with input from F.W.; A.G.R. and F.W. wrote the manuscript with input from N.B. and K.P.

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