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The emergence of contingent reciprocity in young children

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ABSTRACT

Contingent reciprocity is important in theories of the evolution of human cooperation, but it has been very little studied in ontogeny. We gave 2- and 3-year-old children the opportunity to either help or share with a partner after that partner either had or had not previously helped or shared with the children. Previous helping did not influence children's helping. In contrast, previous sharing by the partner led to greater sharing in 3-year-olds but not in 2-year-olds. These results do not support theories claiming either that reciprocity is fundamental to the origins of children's prosocial behavior or that it is irrelevant. Instead, they support an account in which children's prosocial behavior emerges spontaneously but is later mediated by reciprocity.

Introduction

From early on in development, children engage in prosocial behaviors such as helping and sharing (Eisenberg, Fabes, & Spinrad, 2006; Hay & Cook, 2007; Warneken & Tomasello, 2009b). Specifically, during the second and third years of life, children begin to help others with their goals (e.g., Rheingold, 1982; Warneken & Tomasello, 2006) and share resources with others (e.g., Brownell, Svetlova, & Nichols, 2009; Dunfield, Kuhlmeier, O'Connell, & Kelley, 2010; Svetlova, Nichols, & Brownell, 2010). However, it is not known whether these prosocial behaviors of young children are based on direct reciprocity. Direct reciprocity refers to cases in which favors are exchanged over repeated encounters between the same two individuals. Direct reciprocity is a powerful strategy to stabilize cooperation

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among individuals who interact repeatedly because if individuals take turns in who pays a cost and who benefits, both individuals can create a greater long-term benefit (Axelrod & Hamilton, 1981; Nowak, 2006; Trivers, 1971). Thus, both theoretical models and empirical studies with adults (e.g., Gurven, 2006) show that direct reciprocity is an important strategy explaining the emergence of human cooperation. Therefore, the question arises at what point in development children use contingent reciprocity to guide their prosocial behaviors with others.

A few naturalistic observations have explored whether children engage in reciprocity. In studies with young children, reciprocity was often difficult to establish because of low base rates (Murphy, 1937; Strayer, Wareing, & Rushton, 1979), because the situation was too unstructured (Peterson, Ridley-Johnson, & Carter, 1984), or because reciprocal effects were strongly intercorrelated with the overall rate of social interaction (Hay, Castle, Davies, Demetriou, & Stimson, 1999). However, one study provided evidence for weak, but statistically significant, correlations in the domain of helping and sharing among 3- and 4-year-old peers, controlling for friendship and affiliation (Fujisawa, Kutsukake, & Hasegawa, 2008). These observational studies can provide suggestive positive evidence and external validity for reciprocity in young children, but due to the correlational nature of the analyses, they cannot establish what causes the variation in children's prosociality. In particular, they cannot determine whether a child's decision to cooperate or defect is contingent on the partner's previous behavior. Alternatively, reciprocity could be the result of friendship (so-called attitudinal reciprocity) or external factors beyond the child's control (Schino & Aureli, 2010).

One recent study used a more structured situation by using a card game in which children could choose between a selfish distribution of rewards (1 for self, 0 for other) or, at no additional cost, an equal outcome (1 for self, 1 for other) (House, Henrich, Sarnecka, & Silk, 2013). Results showed that children at 5 to 7 years of age were more likely to choose the equal option over the unequal option, with equal choices being more likely if the partner had made the same choice previously. By contrast, children at 3 and 4 years of age chose the equal and unequal options at the same rate throughout the session. These results are intriguing because they indicate that a peer's current choice was associated with the other peer's previous behavior. However, conclusions about the causal effect of previous sharing must be interpreted with caution because they are based on a quasi-experimental setup in which the partner's behavior (the independent variable) was not experimentally controlled and regression statistics cannot fully account for potentially confounding predictor variables. Thus, a stronger test would involve a design with random assignment to different experimental conditions. Moreover, the tendency of younger children to choose cards randomly even though creating equal outcomes came at no additional costs to themselves raises concerns about the validity of the task for a younger age group, especially considering that no task comprehension check was included. Most important for our current purposes, children could benefit the partner without incurring a cost, and thus it is unclear whether a similar result would be obtained if children needed to give up a resource or exert effort in order to benefit the partner.

Overall, although naturalistic and semi-structured studies suggest that the first signs of reciprocal interactions might emerge during middle childhood, because of their correlational nature or the possibility of confounding factors in quasi-experimental designs, it remains unclear whether children in fact respond to the partner's previous cooperativeness. For these reasons, other studies have experimentally manipulated the partner's behavior and the opportunity for reciprocation to assess whether children respond in a reciprocal manner. However, the vast majority of experimental studies have focused on children at 5 years or older, leaving it open whether reciprocity operates when prosocial behaviors first emerge in early ontogeny (e.g., Berndt, 1979; Dreman, 1976; Fishbein & Kaminski, 1985; Keil, 1986; Peterson, Hartmann, & Gelfand, 1977; Staub & Sherk, 1970).

Indirect evidence on the emergence of reciprocity in younger children comes from controlled experiments in which children decide for third parties (dolls) how these agents should divide up resources between other dolls. Specifically, in Olson and Spelke (2008), in a forced-choice situation with unequal numbers of rewards, 3.5-year-olds recommend that the donor should give more to a recipient who had previously shared with them than to the recipient who had not. This result shows that by at least 3.5 years of age, children use the concept of reciprocity to make decisions about sharing situations. Therefore, the question arises as to whether children use these rules for their own prosocial behaviors as well.

Recent studies have focused on helping behaviors and shown that young children help selectively based on the past behavior of a recipient. Dunfield and Kuhlmeier (2010) found that when individuals need to decide whom to help, 21-month-old children prefer to help a person who was nice to them previously over a person who was mean. Specifically, when two individuals simultaneously reached for the same object, children were more likely to give the toy to the person who had previously been willing but unable to share a toy with them over someone who was able but unwilling. Similarly, when 3-year-olds needed to choose which of two people to help first, they were less likely to help someone who had previously harmed a third person than someone with a clean record (Vaish, Carpenter, & Tomasello, 2010). Similarly, 26-month-olds, but not younger children, are more likely to help a cooperative person who in a previous interaction had returned balls to a third person over an uncooperative person who had always taken the balls away (Dahl, Schuck, & Campos, 2013). Taken together, these studies show that 2- and 3-year-old children begin to use social evaluations to guide their helping behaviors based on direct interaction with the potential recipient as well as in third-party interactions. It must be noted, however, that these were all forced-choice situations in which children needed to select whom to help rather than whether to help or not. This contrasts with the situation we are concerned with here: When interacting with a social partner, do children decide to cooperate or defect based on the partner's previous behavior? Moreover, the tasks included only helping, leaving open whether the same applies to costly resource sharing.

We know of only one published experiment that assessed whether young children use contingent reciprocity to decide whether to share or not by giving away a resource. Specifically, Levitt, Weber, Clark, and McDonnell (1985) tested a small sample of 10 peer dyads ranging from 29 to 36 months in a semi-structured quasi-experimental setting. Children were separated through a fence-like structure, and one child was given toys, whereas the other child was toy deprived. Later, the roles were switched one time. Results showed that children never spontaneously shared during the initial phase; they shared only after the mother had prompted them to do so. However, after the roles of "poor" and "rich" child were reversed once, only those children who had received a toy from the peer now shared an unreported number of toys. This study is interesting because it involved actual costs, and it indicates that perhaps children shared because the other child had shared with them previously. However, because in this quasi-experiment the independent variable was not manipulated, results remain correlational. Moreover, it was not reported whether sharing by the second child occurred spontaneously or after prompting from the mother. Last but not least, the recipient's behavior was uncontrolled, and thus it is unclear whether toy transfers occurred because the second child was more willing to share or because the first child was more likely to request.

One can differentiate three possible developmental models about the relationship of prosocial behavior and reciprocity: Reciprocity could influence the emergence of prosocial behavior immediately, later, or not at all (Warneken & Rosati, 2012). Thus, the first model would posit that reciprocity is foundational and prosocial behaviors are regulated by reciprocity from the outset (*reciprocity is primary*). This would make sense because it solves the cheater problem; prosocial behaviors come with a safety mechanism and children avoid being exploited, similar to what we see in adults. The second model suggests that basic prosocial behaviors emerge first, and reciprocity begins to mediate these behaviors later (*reciprocity is secondary*). That is, young children have a basic spontaneous tendency to help and share without taking reciprocity into account, which then becomes mediated by reciprocity later in development. Thus, children start out as rather naive altruists and become more selective as they gain more experience or when other cognitive skills are in place. The third logical possibility is that reciprocity does not influence prosocial behavior in children at all (*reciprocity is irrelevant*). Adults clearly do use contingent reciprocity in their decisions of whether to cooperate or not in some, but not all, social contexts (e.g., Berg, Dickhaut, & McCabe, 1995; Bolton & Ockenfels, 2000; Pruitt, 1970). However, it has been proposed that direct reciprocity characterizes relationships among peers and strangers (equality matching, market pricing) (Fiske, 1992), but not among individuals of different status (authority ranking) or among family members or individuals in tight social groups (communal sharing). Although direct reciprocity is important for adults in certain types of social relationships, it is possible that children might not yet frequently participate in the social–ecologically relevant contexts that give rise to direct reciprocity and, thus, might not yet apply reciprocal strategies.

To choose among these three models, we tested children of two different age groups: 2.5 years, because this is an age at which children reliably help and often share in direct interaction with others, and 3.5 years, because previous studies have shown that at this age children apply a concept of reciprocity in hypothetical sharing situations (Olson & Spelke, 2008). In our procedure, we used two different tasks, helping and sharing, with child and partner alternating roles of donor and recipient over repeated trials to assess whether children modulate their helping or sharing contingent on the other's behavior. Our main research question was whether young children respond in a reciprocal fashion after a social partner cooperated or failed to cooperate with them. We compared three conditions: The partner either cooperated, defected without verbalizing, or defected while verbally expressing a reluctance to cooperate. We chose a large hand puppet as the partner to simulate a peer interaction as the social domain in which reciprocity is most likely to emerge while at the same time keeping the experimental situation standardized.

Method

Participants

We tested children at 2.5 and 3.5 years of age (2.5-year-olds: $M = 30.2$ months, range = 28.1–31.9; 3.5-year-olds: $M = 42.5$ months, range = 40.5–44.1), with 36 participants per age group. There were equal numbers of boys and girls in each age group, equally distributed across conditions. An additional nine children were excluded because they did not detach from the parent ($n = 1$) or due to fussiness ($n = 5$), parental interference ($n = 1$), or experimenter errors ($n = 2$). Children were recruited from a database of a medium-sized city in Germany. Children came from German-speaking households of mixed economic backgrounds.

Design

The basic situation was that players needed resources to play games in which they threw them into apparatuses where they disappeared (see below). Each child was tested in two tasks: *helping* and *sharing*. There were three conditions that were tested between participants: *Cooperate, Defect Verbal*, and *Defect Silent* (see below for details). Task order was counterbalanced, with half of the children starting with the helping task and the other half starting with the sharing task. Players needed resources to play one of two different games, *jingle box* or *zig-zag ramp*, with one game being used in the helping task and the other being used in the sharing task (counterbalanced between participants). Henceforth, we differentiate between rounds and trials. In each *round*, the child started out as the recipient (R) and the partner started out as the donor (D), after which the roles were switched. This was repeated in Rounds 2 and 3. Thus, in a given task, the child was tested in an RD–RD–RD sequence across the 3 rounds. Within each round, there were 2 *trials*, that is, two opportunities for an individual to help the other (in the helping task, two items were out of the recipient's reach, and thus the partner reached twice for out-of-reach objects; in the sharing task, the partner solicited the child's sharing twice according to the solicitation script described below). Tasks were administered in blocks of 3 rounds each without announcing how long the game would last.

Tasks

Helping

The child and partner sat at opposite ends of a table (Fig. 1A). The player was collecting objects from the table to use them in one of the games (six cubes for the jingle box or six marbles for the zig-zag ramp). In test trials where a player needed help, four objects were within reach, so that the partner could pick them up one by one and use them to play the game. However, the last two objects were out of the partner's reach, right in front of the child.

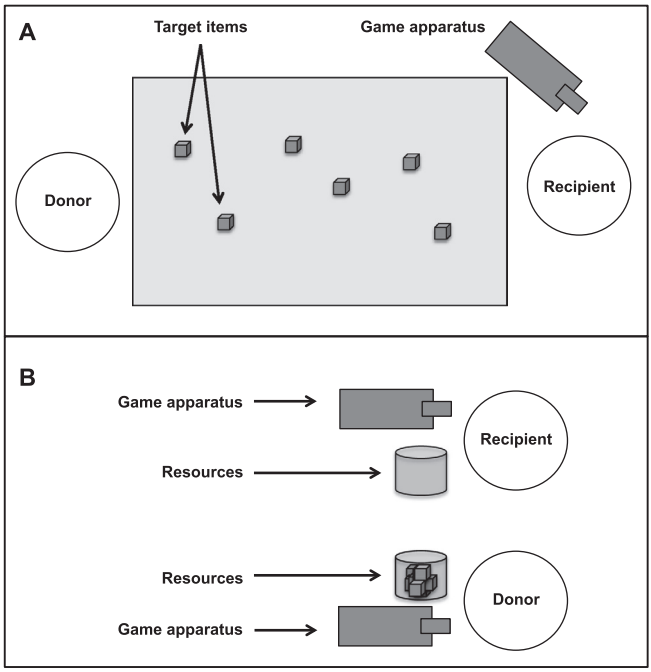

Fig. 1. Schematic drawing of prosocial tasks. (A) Helping task with individuals sitting at opposite ends of a table. (B) Sharing task after the "poor" individual has used up all resources and the "rich" partner has the opportunity to share.

Sharing

The child and partner each played the game individually, but were sitting next to each other on the floor and playing in parallel (Fig. 1B). They each had a transparent container filled with either cubes or marbles, depending on whether they were playing with the jingle box or the zig-zag ramp. In test trials where the partner ran out of toy objects, the child still had eight objects to play with.

Games

The jingle box consisted of a large cardboard box (39 cm long × 30 cm wide × 27 cm high) with a tube on the upper front as an opening (∼10 cm long, 7.5 cm in diameter). When the player threw a cube of 2.5 cm edge length into the tube, it slid into the box and created a jingle sound due to a xylophone installed inside. In the zig-zag ramp game, players threw marbles through a funnel so that they would roll down the ramps and fall into the hole of a box installed underneath (box: 45 cm long × 32 cm wide × 8 cm high; ramp: 48 cm long × 8 cm wide × 18 cm high). The wooden marbles (3.5 cm in diameter) were fined down in one spot so that they would stay in place on the table. In both games, the objects would disappear and players needed more to continue to play.

Conditions

The main manipulation was how the partner responded when the child needed help or required more objects in the sharing task. This factor was tested between participants, and the partner behaved the same way across the whole session.

In the Cooperate condition, the partner helped and shared spontaneously. Specifically, when the child reached for an object or asked for it, the puppet handed it to the child immediately. If the child

did not reach or request verbally, the partner gave the child the object proactively after 5 s. In the helping task, the partner handed over the two out-of-reach objects per round. In the sharing task, the partner gave away four objects while keeping four.

In the Defect Silent condition, the partner looked back and forth between the child and the toy objects but did not hand an object to the child.

In the Defect Verbal condition, the partner also verbally expressed a reluctance to share (e.g., "No, you can't have any," "No, I don't give you any cubes").

Setup and procedure

After a warm-up phase of approximately 5 to 10 min in a waiting area, the child went into the testing room with two experimenters while the parent waited outside, monitoring the session on a video screen. The experimenters were two female research assistants who were unaware of the hypothesis of the study. The first experimenter (E1) explained how to play the games and brought new objects in between trials. She went behind a partition during trials. The second experimenter (E2) was the puppeteer, handling the puppet from the warm-up phase throughout the session. Puppets were large hand puppets similar to the Muppets or puppets used on *Sesame Street* (~40 cm high), allowing puppeteers to open and close the mouths with one hand and manipulate the puppets' hands (sewn like gloves) with the other hand. Each hand puppet wore realistic gender-neutral children's clothes. It was given a name matching the gender of the child and wore his hair open (male) or her hair as pigtails (female). The puppet was treated by E1 in the same way as the child, that is, playing along with the child during the warm-up, receiving explanations about how to play the game, being asked if she or he wanted to play some more, and so forth. E1 never broke character or talked to E2 as an adult. This was intended to make the status of child and puppet as equal as possible. Previous studies using hand puppets (actually less realistic and smaller ones than the ones we used) have demonstrated that children are comfortable interacting with hand puppets and show realistic social behaviors such as teaching, enforcing social norms, and sharing (Rakoczy, Warneken, & Tomasello, 2008; Robbins & Rochat, 2011; Rossano, Rakoczy, & Tomasello, 2011).

Helping task

The helping task was administered at a table (90 cm long × 75 cm wide × 75 cm high) with a high chair for the child at the head of the table and a chair for E2 on the opposite side. The game (either the jingle box or the zig-zag ramp) was installed on a small side table with wheels, which E1 turned to whoever was supposed to play next. After one player was done playing, E1 came into the testing room, placed a large barrier on the table in front of the child, and briefly played with the child (usually using a toy cell phone), giving E2 time to surreptitiously spread out a new set of six objects across the table for the next turn. Subtle markers indicated where to place them on the table. For the *treatment phase* of a given round, there were always four objects placed within the child's reach, whereas two were out of the child's reach but in front of E2. Thus, the puppet displayed the condition-specific behavior (Cooperate, Defect Silent, or Defect Verbal) two times per round, six times in total (3 rounds × 2 trials). After the objects had been spread out on the table, E1 then removed the screen and left. During the *test phase* of a given round, while the partner was collecting the toys from the table to use them on the jingle box or the zig-zag ramp, the child played with one of several distracter toys (in random order: a toy cell phone, a music box, and a clown). The test event was that after the partner had successfully retrieved four objects and thrown them into the game apparatus, the partner unsuccessfully reached for two additional objects that were out of E2's reach in front of the child. Thus, there were two helping trials per round (3 rounds × 2 trials = 6 trials in total per helping task).

Sharing task

The sharing task was administered on the floor, where the child and E2 sat approximately half a meter away from each other. They played their games in parallel, each individually on her or his own apparatus, taking objects out of the transparent box and throwing them into the zig-zag ramp

or jingle box. These objects were marbles for the zig-zag ramp or cubes for the jingle box. E1 gave the boxes with objects to both the child and the partner at the same time and left. For the treatment phase of a given round, E2 timed it so that the puppet still had eight objects at the moment when the child had run out of toy objects. Thus, the child was poor and the partner was rich. The partner then performed the behavior that corresponded to the respective condition (Cooperate, Defect Silent, or Defect Verbal). During the subsequent *test phase* of a given round, E2 timed it so that the child still had eight objects left when the puppet had run out of toy objects. Thus, now the child was rich and the partner was poor, with the partner in the role of the recipient and the child in the position of a potential donor. In a given round, the child could decide how many of the eight objects to continue using on the child's own game and how many to share with the puppet.

Partner's solicitation of sharing and helping

During test events, the partner provided increasingly more explicit cues about her or his needs during three 5-s phases. During *Phase 1*, the puppet partner focused on the object only (helping: reaching for object without eye contact; sharing: shaking and looking into empty container without eye contact). If the child did not respond, the partner during *Phase 2* added an eye gaze and verbalized the problem (e.g., "I don't have any marbles left. I can't play anymore"). If the child still did not help or share, during *Phase 3* the partner produced a direct request by verbally asking the child for help (e.g., "Can I have a marble?" "Can you give me one?") and continuing to reach for the object in the helping task or stretching out the hand with a palm-up gesture in the sharing task. Therefore, test events lasted up to 30 s. The partner continued to play the game if the child helped or shared. If the child did not help or share, the partner repeated the three-step sequence once more until the trial was over.

Coding and preliminary analyses

All coding was done from digital video by a research assistant who was unaware of the research question as well as the study design and who coded all behaviors blind to condition. It was coded whether children helped by handing over the out-of-reach objects and shared by giving the partner a toy object (either by handing it to the puppet directly or by putting it into the puppet's container). In the sharing task this could range from zero to eight (0–8) blocks per round, and in the helping task this could range from zero to two (0–2) helping acts per round. In addition, it was coded during which phase children helped or shared. These were the three phases described above, but we added a fourth category because children frequently helped or shared proactively before the partner provided any cues (Phase 0: proactive; Phase 1: nonverbal cue; Phase 2: verbal cue; Phase 3: verbal request). In the helping task, children sometimes handed both out-of-reach objects to the experimenter (i.e., the object the partner was reaching for plus the adjacent one either at the same time when they handed the first one or shortly thereafter). If this occurred, this was coded as a Phase 0, 1, 2, or 3 helping act depending on when helping was initiated for the first object for Trial 1 and was counted as a proactive (Phase 0) helping act for Trial 2.

The behaviors of 12 randomly selected children were independently coded by a second rater to assess interrater reliability. Reliability was high throughout, with no disagreements in helping, a weighted kappa of .92 for the number of objects shared, and weighted kappas of .93 and .86 for the phase during which children helped and shared, respectively.

Our dependent measures were the mean numbers of objects given in the sharing and helping tasks. We first averaged across the two trials administered in each round, reflecting the mean number of objects given in a round. Preliminary analyses showed no effect of task order or game apparatus in either the helping task or the sharing task. Thus, we collapsed across these factors. In addition, we found a gender effect that we report in more detail below. We used analyses of variance (ANOVAs) with alpha set at .05 (two-tailed).

Table 1
Mean number of target behaviors (sharing and helping) as a function of task and condition.

Condition	Sharing (range = 0–8)		Helping (range = 0–2)	
	2.5 years	3.5 years	2.5 years	3.5 years
Cooperate	1.53 (0.51)	3.17 (0.44)	1.89 (0.05)	2.00 (0.00)
Defect Silent	2.75 (0.73)	2.06 (0.35)	1.83 (0.08)	1.92 (0.08)
Defect Verbal	2.92 (0.56)	1.29 (0.41)	1.86 (0.05)	1.92 (0.06)

Note: Standard errors are in parentheses.

Results

Effects of condition on amount of sharing and helping

In a first set of analyses, we investigated our main research question: Do children modulate their helping and sharing in response to the partner's behavior? Table 1 displays the mean numbers of objects given as a function of condition and age, broken down by prosocial task.

For the sharing task, we first conducted an ANOVA on the mean number of toys shared with age (2.5 or 3.5 years) and condition (Cooperate, Defect Silent, or Defect Verbal) as between-participant factors. This analysis revealed a statistically significant interaction of age and condition, $F(2, 66) = 5.34$, $p = .007$, $\eta_p^2 = .14$. To decompose the interaction effect, we computed ANOVAs separately by age group. These analyses revealed that there was no difference between conditions among 2.5-year-olds, $F(2, 33) = 1.55$, $p = .23$, $\eta_p^2 = .09$, but there was among 3.5-year-olds, $F(2, 33) = 5.60$, $p = .008$, $\eta_p^2 = .25$. Post hoc tests using least significant differences (LSD) for 3.5-year-olds showed a significant difference between the Cooperate and Defect Verbal conditions ($p = .002$) and a trend for Cooperate versus Defect Silent conditions ($p = .057$). Although there was no effect of condition or any significant difference between individual conditions (LSD) among the 2.5-year-olds, one might notice that, at least numerically, sharing was *least* likely in the Cooperate condition. It is possible that the younger children were slightly more likely to share with the partner if they themselves had experienced a lack of resources previously, which characterized the two Defect conditions but not the Cooperate condition. Thus, their immediate prior experience of lacking resources might have slightly influenced their sharing in a direction opposite to that of what would be expected based on reciprocity consideration. Taken together, what we can conclude from these analyses is that 2.5-year-olds did not differentiate between conditions based on considerations of reciprocity. By contrast, 3.5-year-olds differentiated between conditions and shared most in the Cooperate condition, followed by the Defect Silent and Defect Verbal conditions.

To further explore whether the effect of condition on the 3.5-year-olds changed over time, we computed a repeated measures analysis of variance, including round (1, 2, or 3) as a within-participant variable and condition as a between-participant factor. This analysis showed the previously established main effect of condition, $F(2, 32) = 8.36$, $p = .001$, $\eta_p^2 = .34$, and a main effect of round, $F(2, 64) = 5.21$, $p = .008$, $\eta_p^2 = .14$, and no interaction of condition and round. Overall, children tended to increase their sharing, giving means of 1.92, 1.94, and 2.60 toys over Rounds 1, 2, and 3, respectively, and the difference between conditions was apparent across all 3 rounds, with a slight increase over the 3 rounds due mainly to the Cooperate condition (2.5, 3.2, and 3.8 toys over Rounds 1, 2, and 3, respectively) and the Defect Silent condition (1.8, 1.8, and 2.7 toys, respectively), in contrast to the slight decrease in the Defect Verbal condition (1.5, 0.9, and 1.2 toys, respectively). The absence of an interaction of round and condition shows that the difference between conditions was stable across the task.

For the helping task, children showed a performance that was near ceiling. An ANOVA with age and condition as between-participant factors revealed no main effects or any interaction. There was no effect of round when it was included as a within-participant factor.

Table 2
Phase during which a prosocial act occurred in the first trial of a given round, broken down by prosocial task. Numbers are mean percentages.

Phase	Sharing	Helping
Proactive	15.1 (2.7)	31.7 (3.7)
Nonverbal cue	20.8 (3.7)	40.6 (3.7)
Verbal cue	36.9 (4.2)	20.4 (2.9)
Verbal request	27.3 (4.3)	7.3 (2.2)
Total	100	100

Note: Only children who acted prosocially are included ($n = 59$ for the sharing task, $n = 71$ for the helping task). Standard errors are in parentheses.

Effects of condition on latency and cue level in sharing and helping

In a further analysis, we tested whether there was a difference in latencies to help and share. Thus, if children acted prosocially, were they faster in some conditions? For this analysis, we focused on the first trial of a given round only because this is more conservative and more informative about the cue that was necessary to elicit the prosocial behavior. Specifically, in Trial 2, children might have continued to do what they did in Trial 1, and what appears as immediate sharing in Trial 2 might have been preceded by a slower sharing act in Trial 1, occurring only after the partner's verbal request. On average, children helped after 5.1 s (SEM = 0.5) and shared after 11.3 s (SEM = 0.7), with no effect of age, condition, or round on either measure. Thus, the cue level required to either help or share did not differ by condition. Table 2 displays the data broken down by the phase in which children acted prosocially. Perhaps most important, in the vast majority of cases, children helped and shared without a verbal request from the partner. Interestingly, children frequently helped and shared even before the partner provided nonverbal behavioral cues (e.g., reaching for an out-of-reach object).

Effects of gender on helping and sharing

Because preliminary analyses revealed an effect of gender, we included gender as a factor in the main statistical analyses reported above. For the sharing task, an ANOVA with condition (Cooperate, Defect Silent, or Defect Verbal), age (2.5 or 3.5 years), and gender (male or female) showed a main effect of gender, $F(1, 60) = 9.12$, $p = .004$, $\eta_p^2 = .13$, and an interaction of age and condition, $F(2, 60) = 5.79$, $p = .005$, $\eta_p^2 = .16$. When we computed ANOVAs separately by age group with condition and gender as factors, we once again found that there was no effect of condition among the 2.5-year-olds, only a main effect of gender, $F(1, 30) = 5.80$, $p = .022$, $\eta_p^2 = .16$. For the 3.5-year-olds, there was a trend for gender, $F(1, 30) = 3.35$, $p = .077$, $\eta_p^2 = .10$, and the previously established effect of condition, $F(2, 30) = 5.84$, $p = .007$, $\eta_p^2 = .28$. Overall, on average, girls shared 2.9 toys and boys shared 1.7 toys. Taken together, these analyses revealed (a) that girls shared more than boys and (b) the effect of condition among 3.5-year-olds, but not among 2.5-year-olds, was confirmed when controlling for gender.

For the helping task, an ANOVA with condition, age, and gender revealed that girls were more likely to help than boys, $F(1, 60) = 4.76$, $p = .03$, $\eta_p^2 = .07$, and no further significant main effects or interactions. The gender effect was weak, however, with both performing near ceiling; on average, of the 2 trials per round, girls helped in 1.95 trials and boys helped in 1.85 trials. Thus, for boys and girls alike, the partner's behavior displayed in the different conditions had no effect on children's helping.

Discussion

The current study provides several insights into the development of prosociality in early ontogeny. Results suggest that contingent reciprocity begins to matter at 3.5 years of age but not at 2.5 years of age. This pattern is apparent in sharing situations where children need to give up a resource, but not in helping situations where children instrumentally help the partner near ceiling across all conditions. Interestingly, children's response to the partner's defection is not just outcome based, with intentions

also seeming to matter; children are least likely to share when the partner articulates an intention to defect, share most when the partner cooperated, and share at intermediate levels when the partner defects without making the intention verbally explicit. These patterns were similar for girls and boys, although girls were more prosocial than boys overall.

Based on these results, how can we best characterize the developmental trajectories of prosocial behavior and reciprocity? The results speak against the *reciprocity is primary* model, according to which reciprocity is foundational and emerges before or simultaneously with prosocial behavior. This model would predict that children should cooperate only if the partner returns favors and should never (or only minimally) cooperate when the partner does not. However, young children reliably help and share, and even if the partner does not return the favor, young children continue to act prosocially with the partner. It is not until 3.5 years of age that reciprocity begins to play a role for costly sharing. The results are also incongruent with the *reciprocity is irrelevant* model, according to which reciprocity plays no role during childhood. However, at least in the interaction with (simulated) peers, children modulate their sharing contingent on the partner's prior behavior. Overall, the results seem to best fit the *reciprocity is secondary* model, which predicts a progression from naive to selective prosociality (Hay, 1994; Warneken & Tomasello, 2009a). Specifically, a large body of work has shown that during the second and third years of life, children help and share with others. The current data replicate the finding that young children are willing to help spontaneously and that they are willing to share a valuable resource with a social partner in an experimentally controlled setting. It is not until 3.5 years of age that they modulate their sharing contingent on the partner's antecedent behavior. Thus, children seem to develop prosocial tendencies first, which then become mediated by reciprocal strategies later in development.

The current results raise interesting questions about the similarities to and differences with other experimental paradigms. Specifically, the developmental emergence at 3.5 years of age is congruent with the finding that at this age children begin to use reciprocity when deciding for others without needing to pay a cost themselves (Olson & Spelke, 2008). The current data demonstrate that at the same time in development, children begin to use this strategy to guide their own behavior in costly sharing situations.

On the other hand, there are other findings suggesting that children are selective in their prosociality even earlier in ontogeny. Specifically, in the age range of 21 to 26 months, children begin to discriminate between cooperative and uncooperative individuals in forced-choice tasks (Dahl et al., 2013; Dunfield & Kuhlmeier, 2010; Vaish et al., 2010). However, they do not yet seem to use this concept when deciding whether to help or not or how much to share. One potential reason for this difference could be a difference in the independent variable. In the forced-choice tasks the contrast between being a cooperator and being a defector is more salient, instantiated by two people between which the child needs to choose, whereas in the current setup children are confronted with either a cooperator or a defector. However, it is unlikely that the partner's defection went unnoticed in the current study because the children directly experienced the consequence of the partner's behavior in that they could not play their game. Moreover, in the Defect Verbal condition, the partner repeatedly expressed her or his intention (e.g., "No, I don't give you any"), providing unambiguous evidence about the partner's character, and 2.5-year-olds still continued to share with the partner.

An alternative reason for the difference could be in the dependent variable. We were interested in whether reciprocity mediates the decision to cooperate or not, whereas the forced-choice tasks measured which of two people children would prefer to interact with. In other words, previous studies asked the question: If children help, will they help the cooperator or the defector? We asked the question: If there is a cooperator or a defector, will they help or not? The developmental lag might suggest that perhaps children are first able to make decisions about good social partners, being drawn toward cooperators and avoiding defectors, and only later learn how to modulate their prosocial tendencies when they are confronted with a single individual who is (un)cooperative. Thus, this contrast might reflect different modes of social interactions in which humans engage. The forced-choice paradigm better reflects situations that are conceptualized in what has been called "social market theory," describing how individuals navigate the social world by seeking out other cooperators, advertising their own cooperation, and avoiding defectors (Noë & Hammerstein, 1994). By contrast, our situation is more similar to the kind of choices that individuals need to make in classic social dilemma situa-

tions, where the social constellation is fixed and individuals decide whether to cooperate or not (the most well-known social dilemma with the choice between cooperation and defection is the prisoner's dilemma game). Although speculative at this point, it is conceivable that human children are better equipped to cope with the former than the latter because social choice situations not only are relevant for cooperative behaviors but also permeate the social lives of humans and other animals (Schino & Aureli, 2009). Thus, one might suggest that the different methods tap into different, ecologically relevant domains of social interaction.

A few additional details merit further discussion. First, reciprocity mediated sharing but not helping. One likely explanation for this finding is the discrepancy in cost, with children helping near ceiling in the helping task but showing a stronger selfish incentive in the sharing task, resulting in more variable prosocial behavior. This perhaps suggests that children take into account the partner's cooperativeness when they need to sacrifice resources but are more lenient when they are asked a small favor. Nevertheless, it is interesting that children do not reduce their helping even though they could easily retaliate, and refusing to do a small favor would send an even stronger message.

Second, another finding was that 3.5-year-olds tended to share more when the defector remained silent than when the defector expressed a reluctance to share with these children. This indicates that children are not just focused on the outcome but that the partner's intention seems to matter as well. Thus, it is possible that when the reasons for defection are unclear, children seem to not automatically draw the most negative conclusion but instead might give the defector the benefit of the doubt. Intention and outcome do not always match, and social partners need to assume that sometimes the other partner might defect based on an error or pure chance (the "trembling hand" in game theory; Selten, 1975). As a matter of fact, theoretical models of cooperation predict that agents fare better in repeated prisoner's dilemma games when they use forgiving strategies, starting out with cooperation rather than defection to get reciprocity off the ground and forgiving a bad move rather than switching to defection (Rand, Ohtsuki, & Nowak, 2009). Thus, our data provide preliminary evidence that children who are influenced by reciprocity are nevertheless biased toward cooperation rather than defection.

Third, we found that girls were more likely to help and share than boys. We do not discuss this finding in much depth because it was not part of our research question. However, it is worth noting that our condition difference held when gender was taken into account. More generally, this finding is in line with a large body of work showing that when there is a gender difference, girls tend to be more prosocial than boys (Eisenberg et al., 2006). Interestingly, the current results suggest that gender differences are already apparent fairly early in ontogeny.

The current study had several limitations that should be addressed in future studies. First, children interacted with a puppet rather than a real agent. This was a compromise to simulate a peer interaction as closely as possible while keeping the partner's behavior standardized. On the one hand, this feature does not affect our result of a condition difference because a puppet was used in all three conditions. On the other hand, it raises concerns about ecological validity. Therefore, future research should investigate whether the results hold when children interact with real peers in an experimentally controlled setting where the peer can in some way be trained to perform behaviors according to a standardized script. Second, another concern is that children were inhibited from defecting against a puppet that was operated by an adult and would be more likely to defect against a peer. However, the reverse is equally possible, with children being less likely to defect against a peer than against an animated character. We know of no research that provides evidence one way or the other. Previous research shows, however, that young children are perfectly happy to share with, punish, and scold animated hand puppets (Rakoczy et al., 2008; Robbins & Rochat, 2011; Rossano et al., 2011), and thus it seems implausible that this would deter them from ignoring a request to share. It should also be noted that our results are congruent with correlational and quasi-experimental studies that have found reciprocal patterns of sharing among peers (especially House et al., 2013). This suggests that although our results were obtained in a more controlled, but less natural, laboratory setting, they might have ecological validity extending to interactions among peer children. Last but not least, future research should investigate whether the found difference between helping and sharing is actually due to the costs involved, as we speculated above. This would require a more costly helping task to assess whether children are prone to reciprocate in helping situations regardless of the person's antecedent

behavior or whether they attune their helping to the partner's cooperativeness if it requires more effort.

In conclusion, in models of the evolution of cooperation, reciprocity among unrelated individuals plays an important role. One important and perhaps most basic form of reciprocity is direct reciprocity, in which agents cooperate contingent on the behavior of the interaction partner. Here we have shown that in ontogeny, helping and sharing seem to emerge before children begin to worry about direct reciprocity. Later in development, they seem to become more sensitive to reciprocity, adjusting their prosocial behavior accordingly. This developmental pattern makes sense because 2-year-olds probably live mainly in an environment that protects them from exploitation through non-family members, whereas they need to become more vigilant later in life, possibly when interactions with peers become more frequent. Ultimately, a mature human possesses both the prosocial tendencies and the safety measures to modulate them, but "Mother Nature" kick-starts the prosocial tendencies that emerge early in life, and reciprocal strategies develop over ontogeny to make prosociality more selective.

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