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Helping and Cooperation at 14 Months of Age

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Two experiments investigated the proclivity of 14-month-old infants (a) to altruistically help others toward individual goals, and (b) to cooperate toward a shared goal. The infants helped another person by handing over objects the other person was unsuccessfully reaching for, but did not help reliably in situations involving more complex goals. When a programmed adult partner interrupted a joint cooperative activity at specific moments, infants sometimes tried to reengage the adult, perhaps indicating that they understood the interdependency of actions toward a shared goal. However, as compared to 18- and 24-month-olds, their skills in behaviorally coordinating their actions with a social partner remained rudimentary. Results are integrated into a model of cooperative activities as they develop over the 2nd year of life.

Prosocial behaviors such as helping and cooperation are interesting both cognitively and motivationally: To help someone with a problem, the helper must understand the other's unachieved goal and possess the altruistic motivation to act on behalf of the other. Whereas in the case of helping, understanding another's individual goal of action might be sufficient, cooperative activities are based on the formation of a *shared goal.* That is, two or more persons have to perform interdependent roles directed at a shared goal and possess the motivation to mutually support each other's action to reach that goal. These kinds of prosocial behaviors are at the core of the human condition. Indeed, humans might act altruistically and cooperate in ways not found in other primates (e.g., Alexander, 1987; Richerson & Boyd, 2005), giving rise to social-cognitive skills such as complex mind reading and communication (Tomasello, Carpenter, Call, Behne, & Moll, 2005).

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With regard to helping, children as young as 12 months show concern for others in distress and sometimes intervene by comforting them (for an overview see Eisenberg & Fabes, 1998). In addition, children occasionally point to objects another person is looking for as a form of helping through informing others (Liszkowski, Carpenter, Striano, & Tomasello, 2006; see also Dunn & Munn, 1986). Most recently, it has been shown that 18-month-old children perform unrewarded acts of instrumental helping spontaneously and flexibly in diverse situations (Warneken & Tomasello, 2006; see also Rheingold, 1982); for example, children helped an experimenter retrieve an out-of-reach object like a marker he had accidentally dropped on the floor, or opened cabinet doors when the experimenter was unable to open them himself. Importantly, children did not perform these actions in control conditions where no help was needed. In these acts of instrumental helping, the children understood the other's unachieved goal and were motivated to help him achieve it.

Would even younger children perform acts of instrumental helping? Imitation studies have shown that children at around 15 months can represent the goal another person is trying to achieve, reproducing the intended result rather than the observed actions (Bellagamba & Tomasello, 1999; Johnson, Booth, & O'Hearn, 2001). Also, children at 14 months distinguish between purposeful and accidental actions (Carpenter, Akhtar, & Tomasello, 1998). Thus, even younger children could potentially possess the cognitive prerequisites for instrumental helping. Prosocial motivations to provide such help also seem to be in place. For example, comforting behaviors are observed in children shortly after their first birthday (e.g., Bischof-Köhler, 1988; Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992). Thus, one purpose of this study is to establish both to what extent, and in what contexts, acts of instrumental helping occur in children as young as 14 months of age using the tasks developed by Warneken and Tomasello (2006).

With regard to cooperative activities, the prototypical situation is one in which two people act toward a shared goal that neither could achieve alone. For example, two persons have to perform complementary roles to gain access to an object or create some interesting effect. There have only been a few studies showing successful performance by young children in such cooperative problem-solving tasks. In one such problem-solving task, developed by Ashley and Tomasello (1998), children were more than 3 years old before they could successfully cooperate with a peer. Brownell and Carriger (1990, 1991) presented children at 12 to 30 months with problems in which one child had to manipulate a spring-loaded handle to make toys accessible to another child. These tasks proved impossible for the youngest children and very difficult for the 18-month-olds (who succeeded only accidentally, never reliably). Only children of 24 months or older solved the task successfully over repeated trials.

In addition to these studies on cooperative problem solving, there is another line of research investigating how children establish bouts of coordinated action in cooperative games. Most prominently, Eckerman and colleagues have proposed that in 1-year-olds, coordinated social actions are restricted to ritualized games, such as peek-a-boo or rolling a ball back and forth, that rely on the scaffolding provided by an adult (Gustafson, Green, & West, 1979; Ratner & Bruner, 1978; Ross & Lollis, 1987). At around 20 to 24 months of age, however, children also begin to generate coordinated cooperative games in nonritualized contexts, both with adults and peers (see Eckerman, 1993; Eckerman & Peterman, 2001, for overviews). They do this mainly by what the authors have called the "imitative pattern" as the interactants imitate each other's actions on the same object in a turn-taking sequence.

Most recently, Warneken, Chen, and Tomasello (2006) combined these two research traditions by testing children aged 18 and 24 months in four different tasks, encompassing both problem solving and games. For example, in a problem-solving task named the elevator, the goal was to retrieve an object from a cylinder that was embedded in a table. To do so, two people had to perform complementary roles in which one person pushes the cylinder up and holds it in place until the other person takes the object out. In a cooperative game called the trampoline, two people had to lift and simultaneously shake a piece of cloth to bounce a toy cube. The study showed that children at 18 and 24 months of age were able to cooperate with an adult partner in novel tasks of both types (problem solving and games). Their skills in coordinating their actions with the partner significantly improved between 18 and 24 months of age. For example, the older children more quickly went to the correct position and in the case of the elevator held the cylinder in place until the partner could finish the action of fetching the target object. The most interesting findings were obtained when the programmed adult partner interrupted his participation at a specific moment during the activity—a method first used by Ross and Lollis (1987). Children of both age groups frequently communicated to the partner in an attempt to request his cooperation. All children produced at least one such communicative act. For example, they pointed to the apparatus or placed the apparatus in front of the partner. Moreover, 24-month-olds often accompanied such communication with a verbalization. These responses testify that the children understood their own and the partner's action as interconnected parts of a joint activity. In addition, as has been argued by Warneken et al. (2006), these responses can also be taken as indicators that the children were trying to redirect the partner toward a shared goal, insisting on the commitment to mutually support each other's actions in a cooperative activity.

So far, 18 months is the youngest age at which children have been seen to perform coordinated cooperative activities in novel situations. However, only a few studies included younger children in their samples (Brownell & Carriger, 1990, 1991; Eckerman, Davis, & Didow, 1989; Eckerman & Didow, 1989, 1996) and especially the problem-solving tasks were potentially too demanding mechanically. Therefore, the second major purpose of this study is to explore whether children at

14 months of age are able to engage in cooperative activities. Tomasello et al. (2005) proposed that a major step in children's social cognitive development occurs at around 12 to 14 months, when children begin to engage with adults in cooperative activities involving an understanding of interdependent roles aimed at a shared goal. By adapting the cooperative tasks from Warneken et al. (2006) for younger infants, we could test this claim more closely.

In this study, we tested children at 14 months in both helping (Experiment 1) and cooperation (Experiment 2). Based on the findings by Warneken and Tomasello (2006), we selected the six tasks in which 18-month-olds showed robust helping to test whether even younger infants would help in these situations. This set of tasks presented the children with a variety of difficulties in discerning both the adult's goal and the type of intervention necessary. All had control conditions to rule out that the children would perform the same actions independently of the other's need for help. We predicted that there would be more target behaviors in the experimental than in the control conditions. The cooperation experiment was modeled after Warneken et al. (2006). Here, we selected the two (of four) tasks in which 18-month-olds had been most successful (one problem-solving task and one game). Tasks, procedures, and coding were kept similar to the original study to allow age comparisons. Our hypothesis was that 14-month-olds would be less coordinated and less likely to produce communicative attempts during interruption periods than the children at 18 and 24 months of age from the original study.

The final purpose of this study was to examine potential associations between helping and cooperation by examining each individual participant's proficiency at both kinds of prosocial behaviors. Such intraindividual comparisons were not possible with the data from Warneken and Tomasello (2006) and Warneken et al. (2006) because these were separate studies with different samples. On the one hand, one might expect that individuals who are more likely to help are also more skillful in cooperating, because both behaviors may be founded in the same general ability to understand intentions and a prosocial motivation to act with others. Alternatively, helping and cooperation might be only weakly associated, as the former requires an understanding of the individual intentions of others, whereas the latter is built on the formation of shared intentions.

EXPERIMENT 1: HELPING

Both experiments were conducted with the same children in a single test session of approximately 30 to 40 min. During a warm-up phase in the testing room, two experimenters played with the children for about 10 min, showing them the objects used for the helping tasks in between. During the test, Experimenter 1 (E1) was the helpee and Experimenter 2 (E2) operated the camera and timed the trials. Parents were asked to remain passive during testing. In tasks that were administered at a table, the children sat on the parent's lap; otherwise, parents were seated in the corner of the room.

Each child was tested in the six helping tasks (half in the experimental and the other half in the control condition) as well as both cooperation tasks, including the two roles of the elevator task. Blocks of helping tasks and cooperation tasks were alternated with half of the children starting with a cooperation or helping task, respectively. At the end of the session, children received a toy for their participation.

Method

Participants

We tested 24 children 14 months of age (*M* = 14 months, 2 days, range = 13;21–14;13; 14 girls, 10 boys). Three additional children could not be tested because of fussiness. Children were recruited from a database of parents who volunteered to participate in psychological studies, all being native German speakers from heterogeneous socioeconomic backgrounds. The population was the same as that from Warneken and Tomasello (2006) and Warneken et al. (2006).

Helping Tasks and Materials

The situations varied in the type of problem that the experimenter encountered and the type of help that the child could provide. Experimental and control conditions of each task are described next, with number of trials in parentheses. Video clips of the tasks as they were used in the original study Warneken and Tomasello (2006) can be accessed at www.sciencemag.org/cgi/content/full/311/5765/1301/DC1.

Out of Reach

Clothespin (3). In the experimental condition, E1 used clothespins to hang towels on a line. He accidentally dropped a clothespin on the floor and unsuccessfully reached for it. In the control condition, E1 intentionally threw the clothespin on the floor and did not reach for it.

Marker (3). In the experimental condition, E1 used a marker for drawing, accidentally dropped it on the floor, and unsuccessfully reached for it. In the control condition, he threw it on the floor intentionally and did not reach for it.

Paper ball (3). The child and E1 sat at a table, facing each other. Three balls were on E1's side, and three on the child's side. In the experimental condition, E1 collected three balls with tongs and put them into a container. He then tried to reach for each of the other three balls that were on the child's side, but failed because they were out of his reach. In the control condition, E1 took up each of the three paper balls that were next to him and put them back on the table.

Wrong Means

Flap (1). While E1 was outside of the room, E2 showed the box to the child and let the child open the flap to retrieve a toy. E1 returned. In the experimental condition, E1 put his teacup on top of the box and stirred with a spoon. The spoon accidentally slipped through the hole into the box, verbally marked by E1 ("Oops!"). He then attempted to reach through the hole, which was too small for his hand. In the control condition, E1 intentionally threw a spoon through the hole into the box, marking the throw with a playful tone, and then placed his hands on the box.

Wrong End

Books (3). Each child sat on his or her parent's lap at a table. E1 put a stack of books in front of the child and sat down at the other end of the table. In the experimental condition, E1 repeatedly attempted to place a book on the stack, but missed so that the book landed next to the stack. In the control condition, E1 put the pile of books in front of the child and placed another book right next to it.

Physical Obstacle

Cabinet (3). While E1 was outside the room, the E2 tested whether the child was able to manipulate the doors of the cabinet by letting him or her open it once to retrieve a toy. E1 returned. In the experimental condition, E1 opened the door of the cabinet, took a pile of parcels from the other end of the room, and placed them inside the cabinet. He closed the door and fetched more parcels. On returning, he tried to put them into a cabinet, but he bumped into the closed door with his stack of parcels because his hands were full. In the control condition, he initially put the parcels on top of the cabinet. Upon return, he bumped into the doors as he tried to lift the magazines on top of the cabinet.

The behavior of E1 was the same in all experimental trials: During the first 10 sec after the problem occurred (e.g., marker drops on floor, door does not open), he focused solely on the object. During the next 10 sec, he alternated gaze between object and child and in the last 10 sec verbalized his frustration ("Oh, my marker!" "It does not open!"), but never asked the child for help directly. If the child performed the target behavior during any of these phases, E1 continued his action and went on to the next trial or task. E1 never rewarded or praised the child. In control conditions, he focused on the object for 10 sec with a neutral facial expression and then started to alternate gaze between the object and the child for the remaining 20 sec.

Design

Each child was tested in all six helping tasks. Three of these tasks were administered as experimental and three other tasks as control conditions. Thus, each participant received each task either as an experimental or a control condition. Each task was therefore analyzed between subjects with $n = 12$ per condition. It was systematically varied which subset of tasks was selected as the experimental or control condition. The tasks were administered in three blocks: Block A conducted at the table (paper ball, books), Block B preceded by the demonstration of E2 (cabinet, flap), and Block C (marker, clothespin). The order was counterbalanced within and between blocks, with simple alternation between conditions.

Coding and Reliability

All sessions were videotaped and coded by a research assistant who was unaware of the hypotheses of the study. The first author independently coded a random sample of 20% of sessions to assess interrater reliability. First, we coded whether the children performed the target behavior (e.g., handing the marker, opening the cabinet), resulting in perfect agreement ($\kappa = 1.0$). Second, we measured the latencies of the target behavior, starting with the moment in which E1 encountered the problem (e.g., marker lands on floor, E1 bumps into cabinet) and ending with the child touching the target object (e.g., marker, doorknob). The latencies determined by the two coders were highly correlated, $r(28) = .99$, $p < .001$, and the mean difference between the two coders was not significantly different from zero, $t(28) = –0.69$, $p = .49$. Third, we measured whether in reaching tasks children first took possession of the object before handing it over; that is, whether the experimenter was reaching for the object while the children were holding them in their hands, creating a situation that would resemble requesting handover of an object ($\kappa = .80$). Preliminary results showed that there was no effect of gender or task order on these measures.

Results

Figure 1 displays the mean percentage of target behaviors as a function of task and condition. In tasks with multiple trials, the mean percentage of trials with target behavior per total number of trials was computed for each individual. Means in experimental and control conditions were then compared with t tests. In the flap task with only one trial per individual, Fisher's exact test was used to compare helping (yes–no) in either condition (experimental–control). As we had a directed hypothesis, tests were one-tailed. Independent sample t tests ($df = 22$) revealed significant differences between conditions for the tasks clothespin, $t = 1.79$, $p < .05$, partial $\eta^2 = .13$; marker, $t = 2.49$, $p < .02$, partial $\eta^2 = .22$; and paper ball, $t = 4.47$, $p < .0001$, partial $\eta^2 = .48$. In these three tasks, children performed the target behavior signifi-

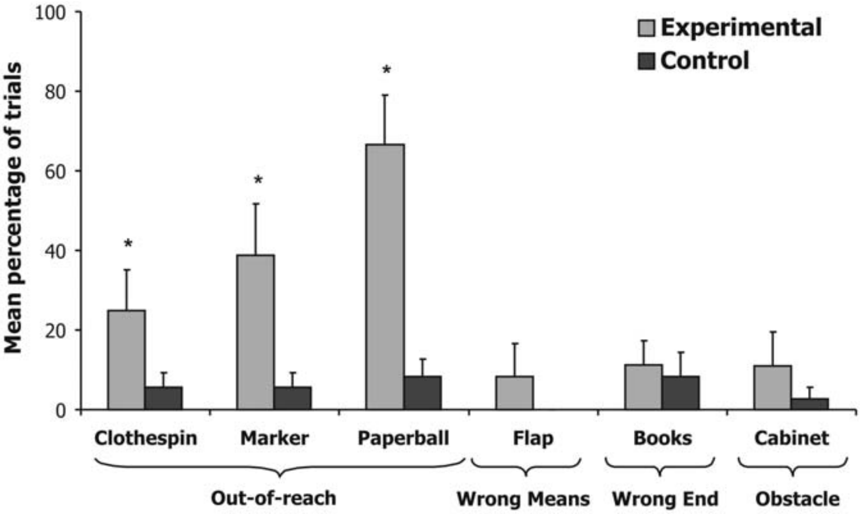

FIGURE 1 Experiment 1: Mean percentage of target behavior by task and condition (with SEM). * $p < .05$.

cantly more often in the experimental than in the control condition. In the remaining tasks, no difference between conditions was found: flap, Fisher's exact test ($N = 24$), $p = .50$; books, $t = .32$, $p = .38$, partial $\eta^2 = .005$; and cabinet, $t = .93$, $p = .36$, partial $\eta^2 = .04$.

Analyzed by individual, 18 of the 24 children helped at least once. Across all tasks, children helped on average in $M = 28\%$ ($SD = 26$) of experimental trials ($M = 39\%$, $SD = 37\%$ of reaching tasks). Thus, the majority of children helped and did so across several trials, mainly in reaching tasks.

Helping occurred very quickly: On average, children helped within $M = 6.9$ sec ($SD = 4.6$) in experimental trials. Accordingly, the great majority of helping acts were performed during the first 10-sec phase in which the helpee focused on the object only, before looking at the child in Phase 2 or verbally referring to the object in Phase 3 (71%, 20%, and 9% in Phases 1, 2 and 3, respectively).

Possessions were infrequent: In most tasks with out-of-reach objects, children handed the object directly to the experimenter. In only 25% of helping acts, children kept it for $M = 6.1$ sec ($SD = 6.6$) before offering it.

Discussion

Children at 14 months of age instrumentally helped another person who could not achieve his goal. They reliably handed out-of-reach objects but did not help in situations with presumably more complex goals. If they helped, they did so spontaneously, never being explicitly asked for help and never being rewarded or praised for their effort. They usually helped while the adult was still focused on the problem. Not only was verbal requesting by the experimenter never used, but for most helping acts eye contact (as a subtle means of soliciting help) was also unnecessary. Control conditions for each task rule out the possibility that children would perform the target behavior irrespective of the other's need.

First, with regard to the motivational aspect of helping, these results speak in favor of the view that an altruistic motivation is already apparent early in human ontogeny, complementing research on empathy (e.g., Eisenberg, 1992; Hoffman, 1981, 2000). The results also corroborate and extend the findings by Warneken and Tomasello (2006) to even younger children. These behaviors probably represent some of the earliest manifestations of human altruism, embodied in acts of helping without immediate benefits to oneself.

Second, the findings shed light on children's cognitive capability of discerning other people's goals. Although they were basically motivated to help, this did not become apparent in all kinds of situations. Namely, children were able to intervene quickly when the experimenter was unsuccessfully reaching for an object, but did not reliably help in the other types of task (wrong means, wrong end, obstacle). One possible interpretation is that in the out-of-reach situations, the actor's goal is in principle easier to identify (an outstretched arm oriented toward a visible object) and the intervention follows straightforwardly. In the other kinds of tasks, the goal might not have been obvious to infants—putting away objects being a less transparent goal than retrieving them—or they did not know how to intervene—as some children committed the same mistake as the experimenter by looking and reaching into the box through the hole, aimlessly fumbling for the spoon.

Alternatively, infants might have interpreted the reaching gestures as a direct request to hand over an object. However, there are three pieces of evidence against this interpretation. First, requests are usually accompanied by eye contact and verbal utterances. However, the children helped spontaneously and quickly, mostly without being addressed through any of these means. Second, the children hardly ever kept the object in their possession while the experimenter was extending his arm toward it; instead they picked it up and directly gave it to him. This indicates that they had formed the intention to hand it over to the adult before they approached the object. Third, the experimenter reached for objects with a grasping gesture different from the familiar palm-up gesture commonly used to request an object, especially in the paper ball task, in which he used tongs, which is even more dissimilar to a prototypical requesting gesture.

With regard to age, it has been shown that infants at 18 months reliably help in all six tasks administered in this study (Warneken & Tomasello, 2006), whereas infants at 14 months help only in the three tasks involving reaching. Future research needs to devise new tasks to further explore the range of contexts in which children at this age might exhibit their proclivity to help altruistically. What we can say at this point is that instrumental helping at 14 months is not yet as general as at 18 months of age, where infants' emerging understanding of goal-directed action enables them to intervene flexibly in disparate contexts.

EXPERIMENT 2: COOPERATION

To investigate early forms of cooperative activities with a shared goal, the children were presented one cooperative problem-solving task and one cooperative game in which they interacted with a programmed adult partner.

Method

Participants

The participants were the same as those in Experiment 1.

Task Descriptions

Elevator. The goal of this task was to retrieve an object from a vertically movable cylinder that is embedded in the platform of the apparatus (a box 28 × 57 cm wide and 46 cm high; transparent barrier 25 cm high; see Figure 2). Before one person could access the object through the opening of the cylinder from one side of the apparatus (Role A), the other person had to position himself or herself on the other side and push the cylinder up from underneath and hold it in place (Role B). It was impossible for a single child to perform both actions simultaneously, as transparent screens prevented reaching to the opening while pushing the cylinder up.

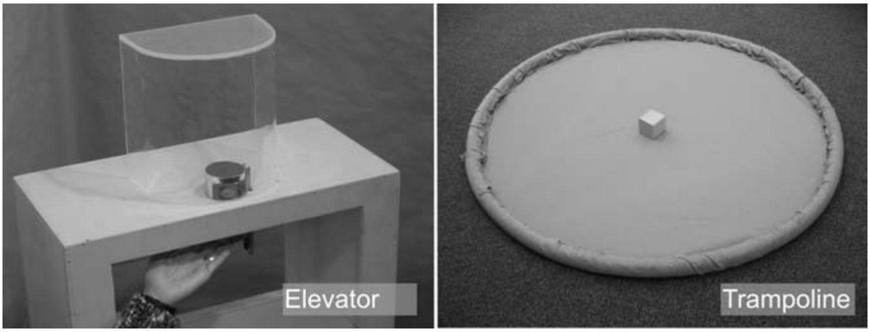

FIGURE 2 Experiment 2: Apparatus used for cooperation tasks.

- *Pretest.* E1 put a ball on the platform on Side A (retrieval side) to check whether the child understood that he or she had to walk around the apparatus to access it.
- *Demonstration.* Before the test, the cylinder had been baited with two objects. It was made sure that the children were watching as one experimenter was pushing the cylinder up three times and the other experimenter was taking one of the objects out, leaving the other object inside for Trial 1. As in all tasks, E2 went in the corner of the room to operate the camera and remained passive during test phases, only returning if additional demonstrations were necessary.
- *Trial 1.* In trials with Role A for the child, E1 pushed the cylinder up, alternating gaze between the child and the object while making a grasping gesture toward the opening. In trials with Role B, E1 positioned himself on the retrieval side and made a grasping gesture toward the opening. It was counted as a success if the child took the object out of the opening in Role A or pushed the cylinder up to make the object accessible to E1 in Role B, respectively. In case of success, Trial 2 was administered. If the child was not successful for 30 sec, the demonstration was repeated by E1 and E2. After the second demonstration, E1 invited the child's participation not only through gaze alternation, but also verbal cues by naming the object for up to 30 sec. In case of success, Trial 2 was administered. If the child continued to fail for another 30 sec, the demonstration was repeated one last time. During the third demonstration, E2 placed the child right next to her and encouraged the child to take the object out with her (Role A) or push the cylinder up with her (Role B). After the demonstration, the first experimenter performed the same behavior as before. In case of success, Trial 2 was administered. If the child did not succeed after 30 sec, the task ended.

Between trials, E1 distracted the child while E2 surreptitiously baited the cylinder with another object. The cylinder was quickly pushed up to display the new object to the child.

- *Trial 2.* E1 invited the child's participation through gaze alternation and vocalizations. Once the object was retrieved, Trial 3 followed. The task ended if the child was not successful after 60 sec.
- *Trials 3 and 4.* These trials were characterized by an interruption period. Once the child engaged in the task, the experimenter interrupted his own actions for 15 sec. E2, who was using a stopwatch, indicated to E1 when the 15-sec period was over. In Role A, he let the cylinder drop when the child was reaching for the object; in Role B, he reached for the object when the child pushed the cylinder up but then withdrew his hand and placed it on the floor. After the interruption period was over, E1 resumed his role or acted like he did at the beginning of the trial if the child had disengaged during the interruption. The same was done in Trial 4.

Trampoline. Two 1-cm-thick C-shaped hoses were connected with flexible joints to form a ring of 58 cm in diameter, which was covered with cloth (Figure 2). Two persons could make a wooden block bounce on the trampoline by holding the rim on opposite sides. However, due to joints in the ring, the trampoline collapsed when being held on only one side. The task was administered at the table with the child sitting on the parent's lap.

- *Demonstration.* E1 and E2 held the rim of the trampoline and let the wooden block bounce on the trampoline for 10 sec.
- *Trial 1.* E1 held one side of the rim and started shaking the trampoline. He alternated gaze between the child and the other end of the rim. The criterion for success was that the child would play the game for at least 5 sec in the next 30 sec. If that was not the case, the experimenters repeated the demonstration. After the second demonstration, E1 alternated gaze and verbalized his intent to play. If the children still did not join the game for 30 sec, a third demonstration was given. During this demonstration, E2 encouraged the child to hold the rim together with her. If the children did not successfully play the game after the last demonstration, the task ended.
- *Trial 2.* E1 played the game for another 5 sec. If the child had disengaged from the task, E1 invited him or her again as in Trial 1.
- *Trials 3 and 4.* After 2 sec of joint play, E1 dropped the trampoline and put his hands on the floor for 15 sec (timed by E2). After the interruption period, E1 resumed playing or acted like he did at the beginning of the trial if the child had disengaged from the task. The same was done in Trial 4 (each lasting up to 5 sec of joint play).

The three administrations of cooperation tasks were presented in counterbalanced order (trampoline, elevator Role A, and elevator Role B).

Coding and Reliability

The coding of the cooperation tasks was based on Warneken et al. (2006). A research assistant who was unaware of the hypotheses of the study performed the coding. The first author independently coded a random sample of 20% of the sessions to assess interrater reliability. Cohen's kappa was calculated for categorical ratings and Cohen's weighted kappa was calculated for ratings with ordinal scales (Fleiss & Cohen, 1973).

To assess the children's level of coordination in adjusting his or her actions with the partner, each trial received one score of a rating scale (see Table 1 for a description of the coding schema). In trials with interruption (Trials 3 and 4), this rating was based on the behavior before and after the interruption (which was analyzed

TABLE 1
Experiment 2: Coding Schema for Level of Coordination

Category	*Definition*
Task: Elevator	
No success[a]	Child does not attempt or fails to retrieve the object from the apparatus (Role A); child does not push the cylinder up and holds it in place (Role B).
Uncoordinated	Success after more than 5 sec of inappropriate actions such as standing on wrong side, letting cylinder drop more than once, individual play, or individual attempts.
Coordinated	Success, but some inappropriate actions or waiting, but not for more than 5 sec.
Very coordinated	Success after immediate understanding of his or her role. Child positions himself or herself in correct location and performs the correct action without making any mistakes.
Task: Trampoline	
No success[a]	Child does not hold and lift trampoline.
Low engagement	Joint play but lots of stopping and not too excited. Child needs a lot of persuasion.
Medium engagement	Some stopping or not too excited.
High engagement	Continuous play and rather excited (placing block on trampoline, initiating play, active shaking).

[a]In unsuccessful attempts, children showed one or more of the following behaviors:

Off-task: The child did not approach the apparatus or did not reapproach after the interruption.

On apparatus, play: The child engages with the apparatus, but without an attempt to retrieve the object in the problem-solving tasks or play that is unrelated to the partner's action like banging on the apparatus.

Bystander: Child positions himself or herself next to apparatus and observes partner's actions, but does not engage in the task.

Individual attempt: Child tries to retrieve the object individually or play the game on his or her own.

separately; see later). This resulted in perfect agreement for the elevator task (κ = 1.0) and a weighted kappa of $\kappa = .94$ for the trampoline task.

For interruption periods, we first assessed the overall behavior during the 15-sec interruption period. If the participant exhibited multiple behaviors in any given interruption period, we categorized the period based on the actions exhibited for the majority of time. With this coding we mainly wanted to determine whether children would rather try to perform the action individually or make some attempt to reengage the partner ($\kappa = .70$; see Table 2 for a description of the rating).

Second, we scrutinized more closely for communicative acts by performing a second-by-second coding using a computer-based observation software (INTERACT). Of particular importance were communicative acts by which children addressed the partner and made reference to the apparatus, reflecting cases in which children attempted to regulate the partner's actions. Those were of three types: (a)

TABLE 2
Experiment 2: Coding Schema for Overall Behavior During Interruption Periods

Category	*Definition*
Disengagement	Child leaves apparatus or plays on apparatus without pursuing the goal of the task by banging on the apparatus, climbing on it, and so on.
Individual attempt	Child attempts to retrieve the object individually in problem-solving tasks or attempts to continue the game alone in play tasks; for example, in the elevator task, the child would come over to the side of the experimenter and push the cylinder up himself or herself while reaching for the object.
Waiting	Child remains on correct side of the apparatus and is ready to perform his or her role.
Reengagement	Child is ready to perform his or her role and in addition tries to reengage E1, for example, by pushing the cylinder of the elevator up, pointing at the object, and vocalizing while looking at the partner.

Note. The 15-sec interruption period served as the unit of analysis: For each interruption period, one of the scores was given.

referential gestures ($\kappa = .92$), such as pointing at the apparatus with the index finger or the whole hand; (b) placing ($\kappa = 1.0$), in which the child moves the apparatus toward the partner; and (c) verbalizations with reference to the partner or the task ($\kappa = .95$), such as "There" or "Look." We also assessed the latency of looks to the partner's face ($\kappa = .89$). Referential gestures mostly occurred in the elevator task when children put their hand on the opening of the apparatus rather than using a prototypical pointing gesture with an extended index finger (17% vs. 83% of trials, respectively). As placing the palm on the opening is slightly ambiguous with regard to its communicative function, we included only those gestures in the analyses that were accompanied by a look to the partner's face, which indicates that the extended arm was actually used as a referential gesture directed at the other.

Results

First we examined whether the 14-month-old children were successful in the tasks at all and how skillfully they coordinated their actions with that of the partner. We supplemented these analyses with comparisons of the performance of 18- and 24-month-old children tested on the same tasks by Warneken et al. (2006). Second, we analyzed children's behavior and communication during interruption periods, including age comparisons with 18- and 24-month-old children. Finally, we searched for correlations between the behavior in cooperation and helping.

Performance

Table 3 displays the number of children who performed the tasks successfully at least once. All children retrieved target objects from the elevator when performing Role A, several of them also across trials. In Role B (pushing up the cylinder), most children failed. In the trampoline task, around two thirds of the children played the game, sometimes over several trials.

How many demonstrations did children need to be successful? Table 4 displays the number of demonstrations that had to be administered before children were successful for the first time. In the elevator task Role A (retrieve), a single demonstration was usually sufficient for them to understand the task and perform their role. Role B (push) was difficult even for the children who were ultimately successful, evidenced by the fact that more than half of them needed repeated demonstrations. If children engaged in the trampoline task, the majority of them did so after a single demonstration.

How skillfully did the children coordinate their actions with the actions of the partner? To assess this, for each child an individual score was calculated sepa-

TABLE 3
Experiment 2: Number of Children With Successful Performance as a Function of Task (and Role)

	Number of Trials With Success					
Task	*0*	*1*	*2*	*3*	*4*	*Total*
Elevator						
Role A	—	5	1	2	16	24
Role B	16	5	—	—	3	24
Trampoline	9	2	1	6	6	24

TABLE 4
Experiment 2: Number (and Percentages) of Successful Children Needing One to Three Demonstrations as a Function of Task (and Role)

	Number of Demonstrations Before Success							
	1		*2*		*3*		*Total*	
Task	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Elevator								
Role A	19	79	3	13	2	8	24	100
Role B	3	38	4	50	1	13	8	100
Trampoline	10	67	4	27	1	7	15	100

rately by task and role (elevator Roles A and B and the trampoline task). As this analysis was based on an ordinal rating scale, we calculated the median for each individual across all administered trials of a given task (and role). For Trial 1 with up to three demonstrations (thus up to three ratings), we chose the performance after the last demonstration that was administered to each child as the level of coordination for that trial (i.e., their performance after Demonstration 2 or 3, respectively). Results are displayed in Figure 3. The 14-month-olds of this study displayed coordinated behaviors in the elevator task Role A of positioning themselves in the right location and retrieving the target object from the cylinder when the partner pushed it up, but they had major problems performing Role B, pushing the cylinder up and holding it in place until the partner could fetch the object. If they pushed up the cylinder at all, they would repeatedly drop it when the other person was just about to take the object out. The majority of children played the trampoline game, but phases of playing and stopping were more frequent than continuous play.

Performance–Age Comparisons

We included the data from Warneken et al. (2006) to test for differences in performance across the three age groups (14 months, $n = 24$; 18 months, $n = 16$; 24 months, $n = 16$). For the ordinal scale rating we used exact Kruskal–Wallis tests,

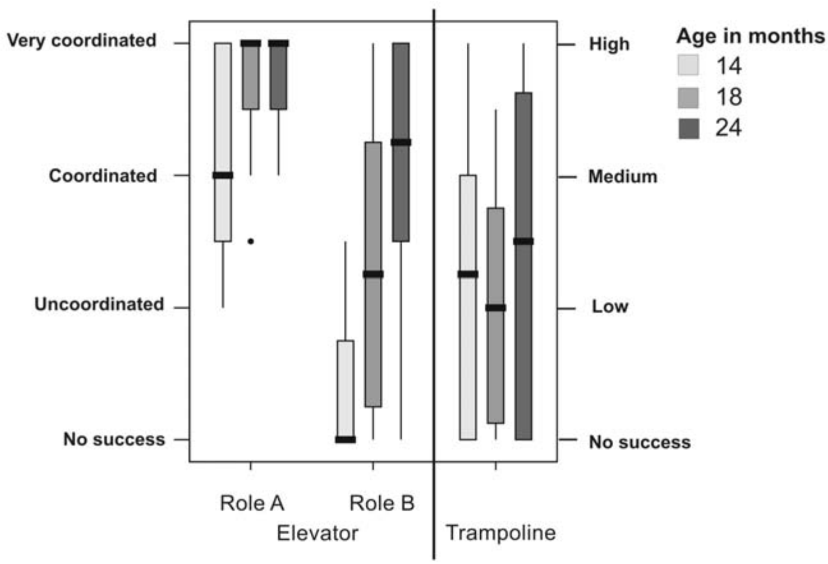

FIGURE 3 Experiment 2: Box plots with median level of coordination (elevator task) and level of engagement (trampoline task) by age group.

followed up by pairwise comparisons. Results for all three age groups are shown in Figure 3. There was an age effect in elevator Role A, $\chi^2(2, N = 56) = 6.67, p < .05$. The 14-month-olds performed worse than 18-month-olds, $\chi^2(1, N = 40) = 3.55, p = .06$, and the 24-month-olds, $\chi^2(1, N = 40) = 5.41, p < .05$. Also in the more difficult elevator Role B, there was a strong age effect, $\chi^2(2, N = 56) = 25.33, p < .001$, with major changes of performance both from 14 to 18 months, $\chi^2(1, N = 40) = 10.24, p < .01$, and 18 to 24 months, $\chi^2(1, N = 32) = 4.88, p < .05$. No age differences were found in the trampoline task, $\chi^2(2, N = 56) = 1.33, p = .52$. Thus, the 14-month-olds showed a similar performance as the older children in the trampoline task and were less coordinated in both roles of the elevator task.

Interruption Periods

As children first had to pass Trials 1 and 2 of each task to proceed to trials in which interruption periods were administered (Trials 3 and 4), children differed in the number of interruption periods depending on their individual performance. Altogether, 21 of the 24 children participated successfully in at least one task such that their responses to interruptions could be recorded. These 21 children were observed in on average 3.1 interruptions (range = 2–5 of 6 possible interruptions). This amounted to 65 interruptions with 59% from elevator Role A, 9% from Role B, and 32% from the trampoline task. To include all 21 children in the analysis, we collapsed interruption periods across tasks and used individual mean proportions as the dependent variable (frequency of behavior divided by total number of interruption periods per individual).

Overall behavior. Figure 4 displays the mean percentage of the 15-sec interruptions that were best characterized by one of four types of behavior (reengagement, waiting, individual attempt, disengagement). An analysis of variance (ANOVA) with the type of behavior as the within-subject factor showed that they were evenly distributed among 14-month-olds, $F(3, 60) = 1.35, p = .27$ (partial $\eta^2 = .06$). The same result was obtained when type of task was introduced as an independent variable for 11 children who could be tested in interruption periods of both tasks, yielding no significant Task × Category interaction, $F(3, 30) = 1.58, p = .22$ (partial $\eta^2 = .14$). On the level of the individual, 12 of the 21 children had at least one interruption period in which they predominately attempted to reengage the partner.

Communicative acts. Based on a second-by-second coding of the interruption periods we calculated for each child the mean frequency of nonverbal communicative acts (placing or referential gesture with looking) and verbal communicative acts across all of his or her interruption trials. Infants produced on average $M = .51$ ($SD = .41$) nonverbal and $M = .09$ ($SD = .25$) verbal communicative acts. Also,

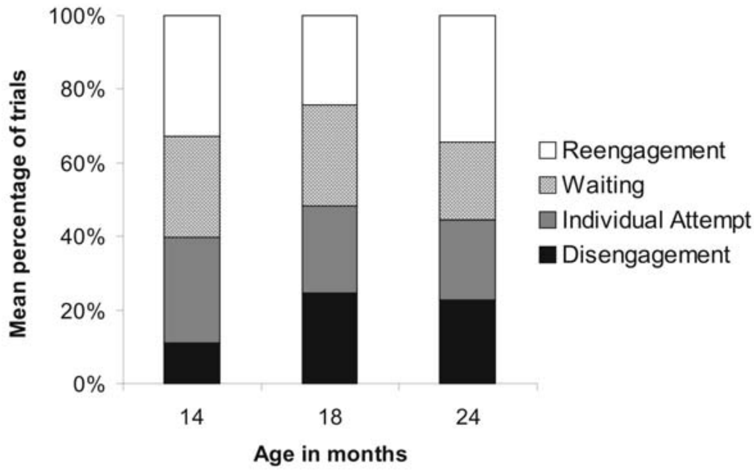

FIGURE 4 Experiment 2: Overall behavior during interruption periods by age group.

we analyzed communicative acts on the level of the interruption period by computing the mean percentage of interruption trials with a communicative act. An interruption with some kind of communication would indicate that the children attempted to regulate the partner. On average, infants used nonverbal means in $M = 39\%$ ($SD = 29\%$) and verbal means in $M = 9\%$ ($SD = 25\%$) of interruption trials. On an individual level, 16 of the 21 14-month-old children who were observed during an interruption period produced at least one communicative act.

Interruption Periods–Age Comparisons

Once again, we included the data from the elevator and the trampoline task from the 18- and 24-month-olds tested by Warneken et al. (2006).

Overall behavior. Figure 4 displays the overall behavior during interruption periods by the three age groups. A mixed model ANOVA with age (14 months, $n = 21$; 18 months, $n = 16$; 24 months, $n = 16$) as a between-subjects and category (disengagement, individual attempt, waiting, reengagement) as a within-subject factor revealed no main effects or interactions (ps > .30, partial η^2s < .025). Thus, the four different behaviors occurred with equal probability and did not vary by age.

Communicative acts. For the analyses, we distinguished between nonverbal (referential gesture and placing) and verbal means of communication. Figure 5 displays the mean frequency of nonverbal and verbal communicative acts as a function of age. A multivariate analysis of variance with age (14, 18, 24 months) as the independent variable and communication (nonverbal, verbal) as the dependent

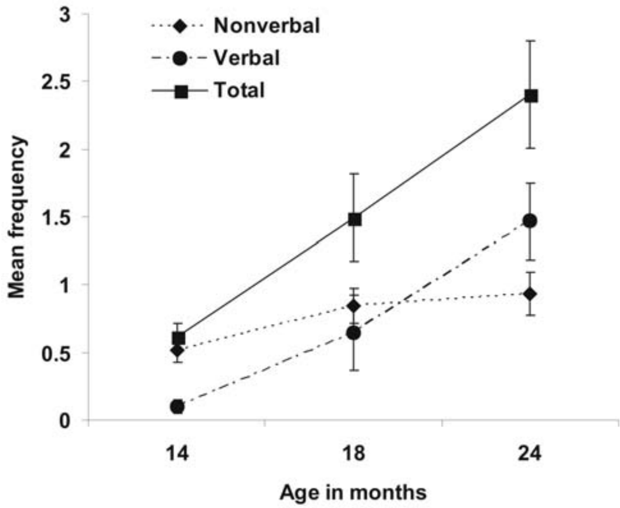

FIGURE 5 Experiment 2: Mean frequency of communicative acts by age group.

within-subjects variable revealed an Age × Communication interaction, $F(2, 50) = 5.79, p < .01$ (partial $\eta^2 = .19$). Univariate analyses, followed up by pairwise comparisons (LSD) showed that age differences were significant for nonverbal communication, $F(2, 50) = 3.59, p < .05$ (partial $\eta^2 = .13$), occurring less frequently at 14 months in comparison to 18 months ($p = .055$) and 24 months ($p < .05$). Effects were even stronger for verbal communication, $F(2, 50) = 10.90, p < .001$ (partial $\eta^2 = .30$), which were observed at 14 months less often than at 18 months ($p = .066$) and 24 months ($p < .001$). The frequency also increased from 18 to 24 months ($p < .05$).

Also the mean percentage of interruptions with at least one communicative act increased significantly over age from *M* = 39% (*SD* = 29%) to *M* = 70% (*SD* = 26%) to *M* = 67% (*SD* = 19%) at 14, 18, and 24 months, respectively, univariate ANOVA: $F(2, 50) = 8.49, p < .01$ (partial $\eta^2 = .25$). Pairwise comparisons showed that the 14-month-olds differed from both older age groups (*p*s < .01).

On an individual level, 16 of the 21 14-month-old children who were observed during an interruption period produced at least one communicative act, whereas all older children did so at least once.

Taken together, all three analyses converge on the finding that a major shift in the probability of communicative acts occurs between 14 and 18 months of age.

Associations Between Helping and Cooperation

We did not find significant associations between 14-month-olds' rate of helping and the cooperation tasks, including both the levels of coordination and the interruption periods (using Spearman rank correlations for ordinal and Pearson correlations for interval scales). The only trend was that infants with a higher percentage of helping across tasks tended to reach a higher level of coordination in the elevator task Role B (pushing), $r_s(24) = .35$, $p = .09$.

Discussion

Children at 14 months of age displayed rudimentary skills in participating in cooperative activities. They successfully engaged at least when the demands on behavioral coordination were low. For example, they played in the trampoline task in which they were already sitting in front of the apparatus and the activity did not require specific temporal adjustment of their actions with that of the partner's. Similarly, children could retrieve an object in the elevator task when the timing depended mainly on the partner, but were usually unsuccessful when they had to hold the cylinder in place until the partner had completed his or her action. This is the first experiment demonstrating instances of successful cooperative problem solving at this early age.

In the study by Brownell and Carriger (1990, 1991), children at 14 months were never successful in a problem-solving task when interacting with a peer. It is possible that our problem-solving task was more intuitive because it depended on gravity rather than a spring-loaded mechanism, but it is more likely that the children were successful because the programmed adult partner performed well-structured behaviors in contrast to peers whose behavior is less predictable and consistent (see also Bakeman & Adamson, 1984). These results seem to imply that children at 14 months are sometimes able to coordinate successfully when one of two roles is being performed in a structured manner, allowing them to engage also in nonritualized activities with unfamiliar partners.

Importantly, these social coordinations show a marked improvement between children at 14 and 18 months of age. This corresponds to the longitudinal study by Bakeman and Adamson (1984), who identified a considerable increase of coordinated joint engagements in free-play situations at home from 15 to 18 months of age, highlighting their emerging skills in coordinating attention to both objects and people triadically. The current age shift also parallels that of Brownell and Carriger (1990, 1991) for coordinating acts in cooperative problem solving with peers and coordinated play with peers and adults between 16 and 20 months (Eckerman, 1993). These studies provide convergent evidence for a major shift in children's ability to organize their attention and actions within shared cooperative activities.

Despite their limited behavioral coordination, if our infants cooperated in the tasks, their understanding appeared to reach beyond that of their own role. Their attempts to reactivate the partner in interruption periods indicate that they were aware of the interdependency of actions—that the execution of their own actions was conditional on that of the partner (see also Ross & Lollis, 1987). On a generous interpretation, these instances might also exemplify a basic understanding of shared intentionality; that is, they can be interpreted as attempts to have the partner recommit to a shared goal (Tomasello et al., 2005; Warneken et al., 2006).

These communicative attempts to reactivate the partner become more frequent and more specific across the second year of life. Whereas the 14-month-olds addressed the partner through eye contact and placing their hand on the apparatus, 18-month-olds typically produce points and 24-month-olds in addition verbalize their communicative intent. Thus, children in the second year utilize their emerging communicative skills to regulate social activities (Eckerman & Didow, 1989, 1996; Ross & Lollis, 1987). It has even been proposed that such cooperative activities facilitate communicative development. For example, Eckerman and Didow (1996) found that verbal means of communication increased only after coordinative activities could be established. Therefore, cooperative activities might set the stage for increasingly more sophisticated means of regulating other people's actions.

GENERAL DISCUSSION

This study establishes that children at 14 months of age understand another person's unfulfilled goal and altruistically help him or her to achieve it. Moreover, they show some rudimentary skills for engaging in cooperative activities. Coordinating joint actions toward a joint goal seems to require cognitive and behavioral skills that are only beginning to emerge at this age. Intraindividual comparisons of infants' performance on helping and cooperation tasks revealed no straightforward associations between the two, suggesting that these activities differ in important ways.

First, the two activities are dissimilar with regard to their intentional structure. Helping might be easier for children than cooperating because it requires the understanding of what another individual intends to do (what actions the other executes to achieve his or her individual goal), whereas cooperation requires the ability to form a shared goal and to mesh plans of action toward that goal (Bratman, 1992). In other words, over and above their understanding of other people's intentions—"He intends to do X by means of Y"—they have to form "we" intentions—"We intend to do X by means of me doing A and you doing B" (Searle, 1990). This new understanding of shared intentionality is probably only about to emerge in children this young (Tomasello et al., 2005).

In addition, performance problems might partly explain differences between tasks. Some of the helping tasks simply did not require a similar degree of temporal and spatial coordination (e.g., handing over an object) as the cooperation tasks (e.g., holding the apparatus for the other to perform his or her role). That is to say, successful cooperative activities depend not only on the representation of a shared goal but also the coordination of mutually supportive actions toward that goal.

In sum, it is possible that helping behaviors ontogenetically precede cooperative activities, corresponding to the understanding of individual intentional action versus the formation of shared intentions. These findings, although far from conclusive, provide evidence in favor of this view. To fully resolve this issue, tasks would be needed that are identical in their physical and mechanical demands but vary solely on the dimension of individual versus shared intentions. Interestingly, and in support of the view that helping is a more basic social skill than shared cooperative activities, we also find a striking difference between helping and cooperation in chimpanzees. In two experiments with the same set of tasks, three nursery-reared chimpanzees helped their human caregiver in various situations involving out-of-reach objects (Warneken & Tomasello, 2006), but did not participate in cooperation tasks to a similar degree as human children (Warneken et al., 2006). Namely, they were not at all interested in cooperative games (including the trampoline task from this study), only in problem-solving tasks with food as the target object (one structurally similar to the elevator task). Most importantly, they never once attempted to reengage the partner when she refrained from cooperating, suggesting that they had not formed a shared goal with the other. Thus, the chimpanzees were able and willing to altruistically help the other with that person's individual goal, but did not seem prepared to engage in activities involving shared intentionality. Human beings, in contrast, appear to be especially adapted for cooperative activities. This study therefore establishes that cooperative activities are a possibly human-specific form of social interaction that children begin to master at around 14 months of age.

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REFERENCES

Alexander, R. D. (1987). *The biology of moral systems.* Hawthorne, NY: de Gruyter.

Ashley, J., & Tomasello, M. (1998). Cooperative problem-solving and teaching in preschoolers. *Social Development, 7,* 143–163.

Bakeman, R., & Adamson, L. B. (1984). Coordinating attention to people and objects in mother–infant and peer–infant interaction. *Child Development, 55,* 1278–1289.

Bellagamba, F., & Tomasello, M. (1999). Re-enacting intended acts: Comparing 12- and 18-month olds. *Infant Behavior & Development, 22,* 277–282.

Bischof-Köhler, D. (1988). On the connection between empathy and the ability to recognize oneself in the mirror. *Schweizerische Zeitschrift für Psychologie, 47,* 147–159.

Bratman, M. (1992). Shared cooperative activity. *The Philosophical Review, 101,* 327–341.

Brownell, C. A., & Carriger, M. S. (1990). Changes in cooperation and self–other differentiation during the second year. *Child Development, 61,* 1164–1174.

Brownell, C. A., & Carriger, M. S. (1991). Collaborations among toddler peers: Individual contributions to social contexts. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 365–383). Washington, DC: APA.

Carpenter, M., Akhtar, N., & Tomasello, M. (1998). Fourteen through 18-month-old infants differentially imitate intentional and accidental actions. *Infant Behavior & Development, 21,* 315–330.

Dunn, J., & Munn, P. (1986). Siblings and the development of prosocial behavior. *International Journal of Behavioral Development, 9,* 265–284.

Eckerman, C. O. (1993). Toddlers' achievement of coordinated action with conspecifics: A dynamic systems perspective. In L. B. Smith & E. Thelen (Eds.), *A dynamic systems approach to development: Applications* (pp. 333–357). Cambridge, MA: MIT Press.

Eckerman, C. O., Davis, C. C., & Didow, S. M. (1989). Toddlers' emerging ways of achieving social coordinations with a peer. *Child Development, 60,* 440–453.

Eckerman, C. O., & Didow, S. M. (1989). Toddlers' social coordinations: Changing responses to another's invitation to play. *Developmental Psychology, 25,* 794–804.

Eckerman, C. O., & Didow, S. M. (1996). Nonverbal imitation and toddlers' mastery of verbal means of achieving coordinated action. *Developmental Psychology, 32,* 141–152.

Eckerman, C. O., & Peterman, K. (2001). Peers and infant social/communicative development. In G. Bremner & A. Fogel (Eds.), *Blackwell handbook of infant development* (pp. 326–350). Malden, MA: Blackwell.

Eisenberg, N. (1992). *The caring child*. Cambridge, MA: Harvard University Press.

Eisenberg, N., & Fabes, R. A. (1998). Prosocial development. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development* (5th ed., pp. 701–778). New York: Wiley.

Fleiss, J. L., & Cohen, J. (1973). The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. *Educational & Psychological Measurement, 33,* 613–619.

Gustafson, G. E., Green, J. A., & West, M. J. (1979). The infant's changing role in mother–infant games: The growth of social skills. *Infant Behavior & Development, 2,* 301–308.

Hoffman, M. L. (1981). Is altruism part of human nature? *Journal of Personality and Social Psychology, 40,* 121–137.

Hoffman, M. L. (2000). *Empathy and moral development: Implications for caring and justice.* New York: Cambridge University Press.

Johnson, S. C., Booth, A., & O'Hearn, K. (2001). Inferring the goals of a nonhuman agent. *Cognitive Development, 16,* 637–656.

Liszkowski, U., Carpenter, M., Striano, T., & Tomasello, M. (2006). Twelve- and 18-month-olds point to provide information for others. *Journal of Cognition and Development, 7,* 173–187.

Ratner, N., & Bruner, J. (1978). Games, social exchange and the acquisition of language. *Journal of Child Language, 5,* 391–401.

Rheingold, H. L. (1982). Little children's participation in the work of adults, a nascent prosocial behavior. *Child Development, 53,* 114–125.

Richerson, P. J., & Boyd, R. (2005). *Not by genes alone: How culture transformed human evolution.* Chicago: University of Chicago Press.

Ross, H. S., & Lollis, S. P. (1987). Communication within infant social games. *Developmental Psychology, 23,* 241–248.

Searle, J. (1990). Collective intentions and actions. In P. Cohen, J. Morgan, & M. Pollack (Eds.), *Intentions in communication* (pp. 401–415). Cambridge, MA: MIT Press.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The ontogeny and phylogeny of cultural cognition. *Behavioral and Brain Sciences, 28,* 675–691.

Warneken, F., Chen, F., & Tomasello, M. (2006). Cooperative activities in young children and chimpanzees. *Child Development, 77,* 640–663.

Warneken, F., & Tomasello, M. (2006). Altruistic helping in human infants and young chimpanzees. *Science, 311,* 1301–1303.

Zahn-Waxler, C., Radke-Yarrow, M., Wagner, E., & Chapman, M. (1992). Development of concern for others. *Developmental Psychology, 28,* 126–136.