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What is This?
How joint attention relates to cooperation in 1- and 2-year-olds

Zhen Wu,1,2 Jingtong Pan,1,3 Yanjie Su,1 and Julie Gros-Louis2

Abstract
Joint attention has been suggested to contribute to children’s development of cooperation; however, few empirical studies have directly tested this hypothesis. Children aged 1 and 2 years participated in two joint action activities to assess their cooperation with an adult partner, who stopped participating at a specific moment during the tasks. Children’s joint attention skills were measured by the Early Social Communication Scales (ESCS). Results showed that children’s responding to joint attention ability contributed to their successful cooperation in an activity that required parallel roles, whereas initiating joint attention ability contributed to their successful cooperation in an activity that required complementary roles. These results suggest a complex relationship between joint attention and cooperative abilities when considering RJA and IJA separately.

Keywords
cooperation, ESCS, joint action, joint attention, toddlers

Joint action, or cooperation in the broad sense, is suggested to form the foundation for human culture (Tomasello, 1999). Though cooperation has increasingly gained scholarly attention, its underlying mechanisms are underspecified. Some researchers have proposed that joint attention, an ability to coordinate one’s attention with another to an external object (Bakeman & Adamson, 1984), is critical for successful cooperation, but few studies have directly tested this hypothesis (e.g., Brinck & Gardenfors, 2003; Carpenter, 2009; Sebanz, Bekkering & Knoblich, 2006; Tomasello & Carpenter, 2007; Tomasello, Carpenter, Call, Behne & Moll, 2005). The current study aimed to test the relationship between joint attention and cooperation in a period when both are developing rapidly, establishing the first empirical step in understanding the underlying mechanisms of cooperation.

Several processes have been suggested to be involved in the development of joint attention skills that may contribute to the development of cooperation. Firstly, joint attention marks the early development of social cognition, such as understanding and sharing one another’s intentions and goals, which are basic requisites of cooperation (e.g., Brownell & Carriger, 1991; Carpenter & Liebal, 2011; Carpenter, 2009; Tomasello, 2009; Tomasello et al., 2005). In this view, children’s cooperative skills become progressively more proficient as they get better at taking others’ actions and intentions into account to adjust their own behaviors accordingly in order to achieve a joint goal. Therefore, processes associated with social-cognitive development may facilitate a link between joint attention and cooperation.

Some other researchers propose that joint attention supports children’s cooperation by creating a kind of “perceptual common ground” that enables two people to experience the same thing at the same time (e.g., Tollefsen, 2005). Within this “perceptual common ground”, one can monitor the attention of others to the outside entity, as well as coordinate one’s own attention and action with others. These abilities, manifested in joint attention, are critical to successful cooperation (Tollefsen, 2005).

A third process involved in the association of joint attention and cooperation may be the integration of pro-social motivation and executive function (Mundy, 1995; Mundy & Sigman, 2006). There is evidence showing that joint attention and executive processes share the same neural mechanisms (e.g., Henderson, Yoder, Yale, & McDuffie, 2002; Mundy, Card, & Fox, 2000). Moreover, infants’ initiating joint attention (IJA, initiate an interaction to direct others’ attention to external objects), shows infants’ motivation to share positive affect (Adamson & Bakeman, 1985; Liszkowski, Carpenter, Henning, Striano, & Tomasello; 2004; Vaughan et al., 2003) and to help others (Liszkowski, 2005; Liszkowski, Carpenter, Striano, & Tomasello, 2006; Tomasello, Carpenter, & Liszkowski, 2007). In addition, responding to joint attention (RJA, follow the direction of gaze and gestures of others to share a common point of reference) is shown to be closely related to attention regulation and inhibitory control, evidenced by the finding that RJA predicts performance in the delay of gratification task (Vaughan et al., 2012). In sum, this theory suggests that IJA and RJA might be involved in different processes that forge the link between joint attention and cooperation.

The above three perspectives agree that joint attention is critical to joint action, which is supported by some empirical evidence. For example, Brownell, Ramani and Zerwas (2006) showed that 2-year-olds’ RJA ability was positively associated with their coordinated actions with peers. In addition, Colombi et al. (2009) found that the impairments in cooperative acts in children with autism might be partly due to lower RJA ability when compared to children with developmental delay. However, these studies did...
not report the relationship between IJA and cooperation. IJA has been found to negatively predict the rating of disruptive behavior while positively predicting social competence and peer play in both typical and atypical children (Sheinkopf, Mundy, Claussen, & Willoughby, 2004; Sigman et al., 1999; Vaughan Van Hecke et al., 2007); however, these studies used questionnaires to rate social competence and peer play and did not measure specific cooperative skills in social interactions.

In this study, we aimed to assess how IJA and RJA relate to 1- and 2-year-old typically-developing children’s skills in coordinating their actions with those of an adult partner. This age range was chosen because the skills of both cooperation and joint attention are undergoing significant developmental changes. Infants’ joint attention develops rapidly between the ages of 12 and 18 months (Bakeman & Adamson, 1984; Tomasello, 1995). Meanwhile, infants start showing some rudimentary ability in coordinating their actions with an adult partner in social games around 14 months of age (Warneken & Tomasello, 2007). This ability improves significantly between 18 and 24 months of age; and further, children older than 2 years of age become proficient cooperators with both adults and peers (Brownell & Carriger, 1991; Brownell et al., 2006; Eckerman & Peterman, 2007; Eckerman, 1993; Warneken, Chen, & Tomasello, 2006).

We modeled two cooperative tasks after Warneken et al. (2006) in which children had to cooperate with an adult partner to achieve a single goal; in addition, the adult partner stopped playing at a predetermined moment to elicit children’s responses, which may reveal children’s cooperative abilities (see also Ross & Lollis, 1987, Warneken & Tomasello, 2007). Two different tasks were used because we aimed to measure different aspects of cooperative skill. One cooperative task involved two complementary roles, that is, two individuals had different but interdependent roles that occurred in sequential time and space; whereas the other task had parallel roles, so that two individuals performed highly similar roles at the same time (see also Brownell et al., 2006). Children’s joint attention skills were assessed by a videotaped structured observation measure—Early Social Communication Scales (ESCS; Mundy et al., 2003). In addition, because language abilities have been shown to relate to both the development of joint attention (Harris, de Rosnay, & Pons, 2005) and cooperation (e.g., Brownell et al., 2006), we measured children’s language abilities in order to control for possible language effects. We hypothesized that both IJA and RJA were associated with children’s cooperative abilities.

Of the 66 participants, 54 children completed the ESCS task, 45 children completed both cooperative tasks, and 62 families filled out the language questionnaires. As a result, only 39 children (11 aged 17 months, 12 aged 21 months and 16 aged 25 months) had complete joint attention, cooperation and language data. The 25 excluded infants were different from the included infants in that they had lower IJA, \( t(64) = -2.02, p < .05 \), and were more likely to disengage and wait in the cooperative tasks, \( t(64) = 3.61, 3.76, \) respectively, \( ps < .001 \). However, these excluded infants did not differ from included infants on the basis of age, language scores, RJA, and other cooperative measures, \( ps > .05 \).

Procedure and design

The session began with a 5–10-min period of warm-up free play, during which a female experimenter (E1) played with the child with a set of toys (different from the experiment stimuli described below). The cooperation task and the Early Social Communication Scales (ESCS, Mundy et al., 2003) were administered individually by E1 in the same room in a counterbalanced order, with a video camera placed in a corner approximately 2.5 m away from the child. Caregivers remained with their children, but were instructed not to direct their child or give any hints of what s/he was supposed to do. They also filled out a demographic questionnaire and a Putonghua Communicative Development Inventory (PCDI; Tardif & Fletcher, 2008) during the session. Another experimenter (E2) helped with demonstrations, timing trials, and operating the camera when E1 was interacting with the child.

Cooperation tasks. Two cooperative tasks were administered counterbalanced for order. One task, the “double-tube task,” involves complementary roles and was modeled after tasks used by Warneken et al. (2006). In this task, two 75 cm-long transparent tubes were placed on a paper-box in parallel, and on a 30° incline. To play this game, one person sends a ball down one of the tubes from the upper side (role A) and the other person catches it at the other end with a can (role B). Therefore, the action of two individuals in this task is complementary and happened sequentially.

The other task, the “music-box task,” involves parallel roles. This task consisted of a colorful paper box (2 m × 0.2 m × 0.1 m) decorated with five colorful lights. There are three plastic buttons on the box, two (buttons “a” and “b”) on one end, and the other one (button “c”) on the other end. The distance between the two ends is long enough that one person is not able to press buttons on both sides simultaneously. If one person presses “a” and the other person presses “c” at the same time, then music and colorful lights will turn on together; if buttons “b” and “c” or “a” and “b” are pressed, nothing will happen. The music and lights shut off if either partner stops pressing the buttons. Therefore, the action of two individuals in this task is the same (pressing a button) and happened simultaneously.

The general procedure of the cooperation tasks were as follows: after a short familiarization, E1 and E2 demonstrated the task three times in order to ensure that children understood how to perform the tasks. For example, they showed how one threw the ball into the tube, and the other used the can to catch the ball. After the demonstration, the coordination phase began: E1 invited the child to perform the tasks with her, and they played twice on each tube with each role in the “double-tube” task, and pressed the button four times in the “music-box” task (each time lasted approximately 5 s and the interval between each of the two trials was also about 5 s).

Method

Participants

Sixty-six 14–30-month-old typically-developing children (36 girls) participated in this study. They were further divided into three age groups: 17 months (SD = 1.24; N = 18; range = 14–18 months; 7 girls), 21 months (SD = 1.40; N = 22; range = 19–23 months; 10 girls), and 25 months (SD = 1.98; N = 26; range = 24–30 months; 19 girls). Six additional children had to be excluded (four because of fussiness; two because of technical problems).

Subjects were recruited through posters and flyers distributed at a Maternal and Child Health Hospital in urban Beijing. Families were all native Chinese speakers, whose socioeconomic backgrounds were middle class by parent report. The test session lasted about 30 minutes, and children received a toy at the end of the session.

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Afterwards, an interruption period occurred twice: when the child engaged in the task, E1 stopped playing her role for 15 s (timed by E2). During interruptions, E1 held the can or the ball in front of her with both hands in the “double-tube” task, or put both her hands on her lap in the “music-box” task while looking at the child, but she did not do or say anything in response to the child. After the interruption, she resumed performing her role. The task was terminated if the child became fussy.

Specific cooperation task-related behaviors were operationally defined and are shown in Table 1. The dependent variables were the rate of successful cooperation during the coordination phase and the proportion of time that children displayed each of four mutually exclusive behaviors during the interruption periods (reengagement, waiting, disengagement and individual attempt).

Interoobserver reliability was established between two raters who independently coded random samples of 30% of the videos. Cohen’s k was calculated for behaviors in the cooperation task, and is shown in Table 1.

**Table 1. Behaviors coded from cooperation tasks and Cohen’s kappa k.**

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>k</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful cooperation</td>
<td>In the “double-tube” task: Number of trials in which child chooses the same tube as the partner when throwing the ball (role A) or holding the can under the tube (role B) within 2 s when the Experimenter is ready, divided by the total trials. In the “music-box” task: Number of trials in which child presses the correct button within 2 s when the Experimenter presses her button, divided by the total trials.</td>
<td>0.95</td>
</tr>
<tr>
<td>During interruption</td>
<td>Reengagement: Child is ready to perform her role and tries to reengage E1, for example, by pulling the partner to the task, pointing at the object, verbalizing while looking at the partner. Waiting: Child remains on the correct side of the apparatus and is ready to perform her role, but does not do anything to reengage the partner (e.g., by gesturing, looking, or verbalizing). Disengagement: Child moves more than arm’s length away or plays on apparatus without pursuing the goal of the task by banging on the apparatus, climbing on it, etc. Individual attempt: Child attempts to continue the game alone in play tasks (e.g., in the “double-tube” task, child throws her ball into tube and then runs to catch the ball by herself in the “music-box” task, the child tries to push both buttons).</td>
<td>0.88 0.72 0.90 0.97</td>
</tr>
</tbody>
</table>

Language measure. Parents completed the short form of the Putonghua Communicative Development Inventory (PCDI, Tardif & Fletcher, 2008), which is a Mandarin version of the MCDI (MacArthur Communicative Development Inventory). It requires parents to report whether their children comprehend (scored as 1) or comprehend and produce (scored as 2) words and gestures (did not score) in a range of specific categories. The final scores were summed over all words checked.

**Results**

We first report results for age and task differences in children’s performance in the cooperative tasks, and then age differences in joint attention and language measures. Lastly, we show analyses of the associations between joint attention and cooperation. Means and standard deviations for the dependent measures are presented in Table 2. Preliminary t tests confirmed that there were no sex differences; thus all analyses were conducted on data collapsed across sex. All analyses were done by using PASW Statistics 17 software.

**Development of cooperation**

**Successful cooperation.** No significant differences were found between the two roles involved in the “double-tube” task (role A: sending a ball down one of the tubes from the upper side; role B: catching the ball at the other end with a can), t(44) = 1.6, p > .05, therefore we collapsed the successful cooperation across these two roles and used the mean successful cooperation rate as the dependent variable. A 3 (Age: 17-, 21- and 25-month-olds, between-subject factor) × 2 (Task: “double-tube” vs. “music-box,” within-subject factor) mixed design multivariate analysis with infants’ successful cooperation as the dependent variable was conducted. There was a significant main effect of age, F(2, 42) = 9.59, p < .001, ηp² = .31. Bonferroni post-hoc analyses found that the 25-month-old infants (M = 0.81, SD = 0.10) cooperated better than 21-month-olds (M = 0.59, SD = 0.16), p = .002, and 17-month-olds (M = 0.59, SD = 0.22),
p < .05, but there was no significant difference between 21-month-olds and 17-month-olds, p > .05. The main effect of task version was not significant, F(1, 42) = .02, p > .05, ηp² = .01, nor was the interaction between age and task version, F(2, 42) = 2.07, p > .05, ηp² = .09.

**Interruption periods.** To test for age and task version differences in children’s behaviors during the interruption periods, we conducted a 3 (Age: 17-, 21-, 25-month-olds, between-subject) × 2 (Task: double-tube vs. music-box, within-subject) × 4 (Behavior: reengagement, waiting, disengagement and individual attempt, within-subject) mixed design multivariate analysis of variance. There was a significant triple interactive effect of age, task and behavior, F(6, 126) = 3.06, p < .05, ηp² = .13, an interactive effect of age and behavior, F(6, 126) = 3.94, p < .01, ηp² = .16, and a main effect of behavior, F(3, 126) = 14.40, p < .001, ηp² = .265, as well as a main effect of age, F(2, 42) = 4.33, p < .05, ηp² = .17. No other interactive effects or main effects were significant, p’s > .05. Further analyses showed that older children displayed significantly less disengagement than younger children, F(2, 42) = 4.54, p < .05, ηp² = .18, but tended to show more reengagements, F(2, 42) = 2.71, p = .08, ηp² = .11 (see Table 2).

When comparing children’s behavior during the interruption periods between these two different tasks, we found that children displayed significantly more individual attempts in the “music-box” task (M = 0.48) than in the “double-tube” task (M = 0.31), F(1, 44) = 5.45, p < .05, ηp² = .11, but less disengagement (Ms = 0.21 vs. 0.38), F(1, 44) = 4.64, p < .05, ηp² = .10, and less waiting (Ms = 0.03 vs. 0.16), F(1, 44) = 8.10, p < .01, ηp² = .16. No significant task difference was found for reengagement behavior, F(1, 44) = 3.08, p > .05, ηp² = .07.

To ensure that the two tasks measure different aspects of cooperative skills, partial Pearson correlational analyses were conducted. With age being controlled, there was no significant correlation between the rates of successful cooperation across these two tasks, r (42) = −.04, p > .05, or across the four categories of behaviors during the interruption periods, r (42) = .16, −.03, −.09, .09 for reengagement, disengagement, individual attempts and wait respectively, p’s > .05.

**Age differences in joint attention and language**

As shown in Table 2, the age effect for IJA total was not significant, F(2, 51) = 2.64, p > .05, ηp² = .08. Infants’ RJA increased with age, F(2, 51) = 3.33, p < .05, ηp² = .12, so did the total language score, F(2, 59) = 30.01, p < .001, ηp² = .50.

Pearson correlations showed that there was no significant correlation between infants’ IJA and RJA, r (52) = −.02, p > .05. In addition, infants’ language was not correlated to infants’ IJA, r (48) = −.13, p > .05, but was positively correlated to RJA, r (48) = .29, p < .05. However, the correlation between language and RJA changed when age was controlled, r (47) = .05, p > .05.

**Associations between joint attention and joint action**

Pearson correlations showed that infants’ language scores related to their disengagement during the interruption period, r (52) = −.38, p < .01, and also had a marginally significant relationship with reengagement behavior, r (52) = .27, p = .05, as well as the rate of successful cooperation, r (52) = .24, p = .08. To be conservative, infants’ age and language scores were controlled when Pearson correlations were conducted to determine whether children’s joint attention associated with their performance in the cooperative tasks.

Pearson correlation results showed a different relationship between joint attention and joint action regarding the different tasks (see Table 3): (1) in the “double-tube” task, children’s IJA positively related to successful cooperation and reengagement, and negatively related to disengagement, r (35) = .54, .33 and −.33, respectively, ps < .05. By contrast, none of the relationships between RJA and cooperative measurements were significant, ps > .05; (2) In the “music-box” task, we did not find any significant correlations between IJA and infants’ cooperative measures, ps > .05; instead,
Table 3. Summary of Pearson correlations between infants' joint attention and cooperative abilities after controlling for age and language.

<table>
<thead>
<tr>
<th></th>
<th>“Double-tube” task</th>
<th>“Music-box” task</th>
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<tbody>
<tr>
<td></td>
<td>Coop.</td>
<td>Reengagement</td>
</tr>
<tr>
<td>IJA</td>
<td>.54&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.33&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>RJA</td>
<td>.26</td>
<td>.19</td>
</tr>
</tbody>
</table>

Note. *Coop: successful cooperation; <sup>a</sup>p < .01; <sup>b</sup>p < .05, N = 39.

Table 4. Hierarchical regression predicting successful cooperation and behaviors during the interruption period.

<table>
<thead>
<tr>
<th></th>
<th>“Double-tube” task</th>
<th>“Music-box” task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cooperation</td>
<td>Reengagement</td>
</tr>
<tr>
<td>R²</td>
<td>0.32</td>
<td>0.31</td>
</tr>
<tr>
<td>F of R² change</td>
<td>5.23&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.90&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Age&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.83&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.21&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>IJA&lt;sup&gt;e&lt;/sup&gt;</td>
<td>2.60&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.21&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>RJA&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.81</td>
<td>0.19</td>
</tr>
<tr>
<td>Language</td>
<td>-1.43</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Note. *p < .05; <sup>b</sup>p < .01; <sup>c</sup>value of ts in the regression model. Abbreviations: IJA: initiative joint attention; RJA: response to joint attention.

Infants’ scores of RJA were positively related to successful cooperation and reengagement, but negatively related to disengagement, r(35) = .35, .38, and -.54, respectively, ps < .05; (3) IJA and RJA were not related to children’s waiting or individual attempt in either task, ps > .05.

Based on these correlational results, age, joint attention and language were entered together as predictors into separate multiple hierarchical regression analyses using successful cooperation and children’s behavior during the interruption period (reengagement and disengagement) as dependent variables (see Table 4). The behaviors of individual attempt and waiting were not analyzed because they were not related to IJA or RJA according to the correlational analyses. For the proportion of successful cooperation in the “double-tube” task, age and IJA entered the regression equation, and together predicted 32% of the variance; however, RJA and language did not predict successful cooperation in the “double-tube” task. For the proportion of successful cooperation in the “music-box” task, age and RJA entered the regression model, and together explained about 21% of the variance, but IJA and language were not predictive in this model.

Furthermore, IJA and RJA differentially related to behavior during the interruption periods. IJA predicted children’s reengagement behavior (β = .20, p < .05) in the double-tube task, but not in the “music-box” task. By contrast, RJA predicted children’s reengagement (β = .40, p < .05) and disengagement (β = -.53, p < .01) in the “music-box” task but not in the “double-tube” task. Age was a significant predictor for infants’ reengagement (β = .45, p < .01) and disengagement behavior (β = -.52, p < .001) in the “double-tube” task, but not in the “music-box” task (see Table 4).

**Discussion**

In this study, we examined toddlers’ development of cooperation and its relation to joint attention. We found age-related changes in toddlers’ ability to coordinate their activity with an adult on two tasks that required joint actions. As children get older, they are more likely to reengage the adult partner to achieve a joint goal, and less likely to disengage. In addition, we found that children with more advanced joint attention abilities were better able to coordinate with an adult partner, after controlling for their age and language ability.

Interestingly, our results showed that distinct joint attention abilities differentially related to cooperative abilities in activities that require different roles. Specifically, IJA related to children’s successful cooperation and reengagement attempts in a task that required complementary roles, whereas RJA related to children’s successful cooperation and reengagement attempts in a task that required parallel roles. These findings imply that IJA and RJA may play different roles in the development of cooperation. Previous accounts have proposed that processes of social cognition and pro-social motivation, in combination with executive function, underlie the association between joint attention and cooperation (e.g., Carpenter, 2009; Carpenter & Libal, 2011; Hobson, 2005; Mundy, 1995; Mundy & Sigman, 2006; Tollefsen, 2005; Tomasello, 1995; Tomasello, 2009; Tomasello et al., 2005). Based on these hypotheses, we can speculate about why the particular associations between IJA, RJA and cooperation emerged. Researchers have shown that RJA is quite different from IJA. For example, RJA is related to the posterior attention system, which regulates the development of orientation to biologically meaningful stimuli, such as human eyes (Posner & Petersen, 1990; Rothbart, Posner, & Rosicky, 1994), while IJA is associated with the anterior attention system that regulates more volitional and intentional functions (Henderson et al., 2002; Mundy et al., 2000; Mundy, 2003; Mundy & Vaughan Van Hecke, 2007; Rothbart, et al., 1994). Adamson and Bakeman (1985) found that infants’ sharing of positive affect was significantly related to IJA, but not RJA, suggesting that IJA may reveal a relative eagerness for social engagement and attention elicitation (Mundy & Sigman, 2006). By contrast, RJA may be more likely to be associated with response inhibition (Vaughan Van Hecke et al., 2012).
Considering our study, the adult partner played more of a scaffolding role in the “double-tube” task when the two individuals had complementary roles, so it may have been more important for children to take the initiative role and elicit the adult’s attention to achieve joint action. By contrast, in the “music-box” task, which involved parallel roles, the adult pressed her button first, and children had to press the correct button within two seconds for successful cooperation. Therefore, it was more important for children to detect and follow the adult’s attention, as well as to inhibit their response (wait to push the correct button within a certain time) in order to succeed. In addition, in the “double-tube” task, children were observed frequently to direct the adult to the tube chosen by them even when the adult was ready to play at the other tube. This happened less frequently in the “music-box” task because the adult had only one button to press; hence, in order to achieve the goal, it was important for the child to monitor the adult’s activity. Moreover, there were no significant correlations between children’s performance in these two tasks, suggesting that they measured different aspects of cooperative skills. Therefore, it might be that the different characteristics of tasks lead to different demands of social motivation and executive function that result in differential associations between joint attention and joint action considering IIA and RJA separately.

Several features of this study limit its generalization and require further investigation. Firstly, the current sample is relatively small and homogeneous with the majority of participants coming from middle SES families. Much more needs to be done to understand how diversity of individual differences accounts for social outcomes. Secondly, the attractiveness of the tasks and the role assignments might not be comparable in these two cooperative tasks. Though the rate of successful cooperation and reengagement behavior did not differ between these two tasks, children showed more individual attempts, but less disengagement and waiting behavior in the “music-box” task than in the “double-tube” task. One possible explanation is that the “music-box” task in our study might be more interesting than the “double-tube” task, so that children were less likely to disengage. In addition, the role assignments in the “music-box” task might be less clear than in the “double-tube” task. In the “double-tube” task, the child and the experimenter each had a different tool (a ball to throw or a can to catch the ball), which made it easier for the child to understand that the two should play together; however, in the “music-box” task, each one just needed to press the buttons, which may lead to more individual attempts, even though s/he was unable to press buttons on both sides. These possibilities suggest the need for further studies to control for these issues.

In addition, the association between joint attention and cooperation might have been due to a third variable, such as general cognitive development, temperament, social and environmental factors, etc. (Mundy et al., 2007; Nichols, Martin, & Fox, 2005; Vaughan Van Hecke et al., 2007). Notably, the language ability measured by PCDI in the current study did not predict cooperative skills. This is consistent with previous findings that early language development plays little role in the associations between joint attention and subsequent social and behavioral outcomes (Rescorla & Achenbach, 2002; Vaughan Van Hecke et al., 2007). As suggested by Vaughan Van Hecke et al. (2007), it might be that cognitive and language status only accounts for individual differences in atypical populations (Beitchman, Hood, & Inglis, 1990), or the PCDI did not provide sufficiently precise and specific measures of cognitive and language skills involved in cooperation (see Brownell et al., 2006 that language about self, others and mental states predicted peer cooperation). Future studies are required to measure individual differences in children’s developmental status, which may help clarify whether other variables account for the observed relations between joint attention and cooperation.

In sum, our results suggest that, after controlling for infants’ age and language abilities, infants’ initiative joint attention relates to cooperative ability in an activity that requires complementary roles, while responding to joint attention relates to cooperative ability in an activity that requires parallel roles. More studies are needed to investigate why these particular associations emerged. By studying how children’s different joint attention abilities contribute to cooperative capacity in various activities, we can get a more comprehensive, reliable and detailed picture of what underlies the development of cooperative skills. Moreover, longitudinal studies will be helpful to investigate the direction of causality between joint attention and the development of cooperative skills.

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