Developmental evidence for enhanced theory of mind for
competitive versus cooperative contexts

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Abstract

There is a debate regarding the function of theory of mind (ToM), the capacity to infer, attribute, and reason about mental states. On the one hand are evolutionary and psychological work suggesting that ToM is greater for competition than cooperation. On the other hand are findings and theories promoting greater ToM for cooperation than competition. We investigate the question of whether ToM is greater for competition than cooperation or vice versa by examining the period of development during which explicit ToM comes online. In two studies, we examined preschool children's abilities to explicitly express an understanding of false beliefs—a key marker of ToM—and ability to apply that understanding in first-person social interactions in competitive and cooperative contexts. Our findings reveal that preschool children are better at understanding false beliefs and applying that understanding in competitive contexts than in cooperative contexts.

Introduction

Cooperation and competition comprise two basic forms of social interaction. At first glance, successful cooperative and competitive interactions both appear to require the capacity to infer, attribute, and reason about people's minds (e.g., thoughts, beliefs, intentions), a capacity often referred to as theory of mind (ToM). Indeed, to successfully help another person, one must understand both that the person needs help and what he or she needs help with. Similarly, to compete effectively against another person, one must understand what one's opponent is thinking in order to oppose him or her effectively.

Although ToM facilitates both cooperation and competition, some evidence suggests that ToM has developed primarily in service of competitive aims. Prior work on the evolutionary origins of ToM provides evidence for rudimentary ToM capacities in non-human primates in the ecologically salient domain of competition (e.g., over scarce resources such as food), as compared to cooperation (e.g., Hare, 2001; Hare, Call, Agnetta, & Tomasello, 2000; Hare, Call, & Tomasello, 2006; Hare & Tomasello, 2004; Lyons & Santos, 2006; Melis, Call, & Tomasello, 2006). The primarily competitive nature of social interactions among non-human primates and environmental pressures such as limited resources (e.g., for food and mating opportunities) may have favored individuals who could represent the perceptions and simple beliefs of conspecifics — an ability that may have been preserved in the hominid lineage. These findings are in line with evolutionary accounts of ToM as having evolved for Machiavellian aims (Byrne & Corp, 2004; Byrne & Whiten, 1988). Even among human children and adults, agents that display negative behavior, as compared to neutral or positive behavior, are particularly strong triggers for ToM in the service of understanding those agents' present and future behaviors (Morewedge, 2009; Vaish, Grossmann, & Woodward, 2008; Waytz et al., 2010).

On the other hand are findings and theories suggesting that, in humans, ToM may have emerged to facilitate cooperation. Unlike our closest ape relatives, humans are “cooperative breeders”: individuals distantly related or unrelated to a child often serve as caregivers (“alloparents”), engaging in active food sharing and providing shelter and protection (Hrdy, 2009). It has been argued that the need to identify individuals in one’s environment who are most likely to provide optimal care has facilitated the emergence of advanced ToM in humans. This conclusion is supported by the observation that other cooperative breeders in the primate lineage, most notably callitrichids, are largely deficient to apes and various other non-cooperative breeding primates in general cognitive functioning, but nevertheless have relatively advanced social-cognitive abilities (Burkart, Hrdy, & Van Schaik, 2009; but see Thornton & McAuliffe, 2015). Relatedly, experimental work in human adults reveals a greater tendency for people to consider the minds of ingroup members (who are more likely to be cooperators) than outgroup members (or competitors) (Kelman, 1973; Leyens et al., 2000; Opatow, 1990; Struch & Schwartz, 1989).

We previously investigated the question of whether ToM is greater for competition vs. cooperation or vice versa in adults, using overall levels of activity in brain regions implicated in ToM as a proxy for the cognitive process of ToM (Tsoi, Dungan, Waytz, & Young, 2016). We found that while overall levels of activity within ToM regions were similar for cooperative and competitive interactions, these regions nevertheless encoded information separating cooperation from competition in their spatial patterns of activity. Given these results, it may appear that ToM is neither recruited more for competition than cooperation or vice versa, though the distinction between cooperation and competition remains relevant to social interactions.

The approach we take in the current work is to examine the period of development during

which explicit ToM comes online. Many developmental studies of ToM have focused on false belief understanding, that is, the understanding that people can have beliefs that contradict reality (Wimmer & Perner, 1983). The ability to understand false beliefs has been shown to emerge during the preschool years, approximately 4 years of age (for a review, Wellman, Cross, & Watson, 2001). At this point in development, children start being able to make explicit predictions and inferences about people's false beliefs. While there is growing evidence of implicit false belief understanding in infants (e.g., Onishi & Baillargeon, 2005; for a review, see Scott & Baillargeon, 2017), the focus of the current studies is on (1) the explicit expression of false belief understanding and (2) the application of that understanding to first-person social interactions.

Here, in two studies, we test whether children, at the age during which explicit ToM comes online, are better at understanding false beliefs in competitive contexts than cooperative contexts or vice versa. In Study 1, we build on an extensive body of literature on preschool children's explicit performance on a classic false belief task (Perner & Roessler, 2012; Wellman et al., 2001; Wimmer & Perner, 1983) and test whether preschool children's false belief understanding is better for processing mean (competitive) versus nice (cooperative) interactions. In Study 2, we depart from traditional ways of measuring ToM as tapped by Study 1, that is, in third-party contexts during which participants observe and assess the behaviors of others (non-interaction partners). Instead, we test ToM during first-person social interactions and use the capacity for deception (i.e., planting a false belief in someone else's mind) as a proxy for ToM (Chandler, Fritz, & Hala, 1989; Hala, Chandler, & Fritz, 1991; Lee, 2013; Premack & Woodruff, 1978; Woodruff & Premack, 1979). Specifically, we examine whether preschool children are better able to plant a false belief in another's mind to achieve a competitive goal (i.e., to be the

sole winner of stickers) versus a cooperative goal (i.e., to be joint winners, together, of stickers).

General Methods

Participants

Six hundred and seventy-seven children were recruited from a community-based science center and tested in a soundproof room dedicated to behavioral science research. A legal guardian provided informed consent for all children.

Most participants were assigned to both Studies 1 and 2 (N=627). We had a predetermined goal of 60 participants per cell (roughly 30 per gender), based on the cells in Study 2 and our assumption that dropouts would be high (an outcome typically found in science centers; e.g., Workshop on Research and Museum Partnerships, Cognitive Development Society Meeting, October 2015; Gonzalez, Steele, & Baron, 2017; Gonzalez, Dunlop, & Baron, 2016). We aimed to stop when we estimated that we reached that target. Because the policy at the science center is to not turn away participants if they want to participate, we sometimes went beyond our stopping rule for overpopulated ages. For Study 1, the final sample consisted of 537 participants: 147 three-year-olds (74 females), 266 four-year-olds (137 females), and 124 five-year-olds (55 females). For Study 2, the final sample consisted of 541 participants: 166 three-year-olds (89 females), 251 four-year-olds (130 females), and 124 five-year-olds (54 females). Breakdown of sample size per cell and detailed information on exclusion criteria are reported in Supplementary Material.

Study 1

Methods

Procedure

Participants were introduced to a modified version of the Sally-Anne task (Baron-Cohen, 1985) in the form of a live puppet show. Participants were assigned to either the *Nice Anne* condition or the *Mean Anne* condition (counterbalanced across participants; see complete script in Supplementary Material). In the *Nice Anne* condition, Anne, who is a nice girl, moves Sally's ball from the basket to the closet while Sally is away because she wanted to help Sally. In the *Mean Anne* condition, Anne, who is a mean girl, moves Sally's ball from the basket to the closet while Sally is away because she wanted to trick Sally. After the puppet show, participants are asked the following questions: (1) Where will Sally look?, (2) Where does Sally think her ball is?, (3) Should Anne and Sally be friends?, (4) Is Anne a nice girl or not a nice girl?, (5) Is Sally a nice girl or not a nice girl?. The order in which Questions 1 and 2 were asked was counterbalanced across participants. The focus of this paper is on responses to Questions 1, 2, and 4; descriptive statistics for responses to the remaining Questions 3 and 5 are provided in Supplementary Material.

Analyses

Analyses were conducted in R (version 3.3.3; R Core Team, 2015). Responses were analyzed using a Generalized Linear Mixed Model (GLMM) with binary response terms (correct [1] or incorrect [0]). We were primarily interested in whether responses (correct vs. incorrect) depended on Condition, Question Type, and Age. Thus, our full model included the following predictor variables: Condition (Mean Anne or Nice Anne), Question Type ("Where will Sally look" or "Where does Sally think her ball is?"; manipulated within-participant), Age Category¹ (three, four, or five), and Gender (male or female). Because the standard question ("Where will

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¹ Analyses using Age as a continuous variable revealed the same pattern of results, reported in Supplementary Material.

Sally look?”) might be difficult in that it requires integrating a belief about Sally’s mental state as well as knowledge of how mental states can affect motor behavior, we also included a question probing just the belief (“Where does Sally think her ball is?”)—hence, we included Question Type as a factor. We examined the three-way interaction between Condition, Question Type, and Age Category, the three two-way interactions (Condition x Question Type, Condition x Age Category, and Question Type x Age Category), and the main effects of these variables. Participant was entered as a random effect. To assess the importance of our predictors of interest, we performed likelihood ratio tests (LRTs) and examined whether the model including a given term provided a significantly better fit to the data than the model without that term.

Results

Overall, we did not see any interactions involving Condition (Mean Anne or Nice Anne). That is, likelihood ratio tests revealed no three-way interaction between Condition, Question Type, and Age Category ($\chi^2(2) = 3.719, p = 0.16$), no two-way interaction between Condition and Age Category ($\chi^2(2) = 0.687, p = 0.71$), and no two-way interaction between Condition and Question Type ($\chi^2(1) = 2.344, p = 0.126$). There was, however, an interaction between Question Type and Age Category ($\chi^2(2) = 10.866, p = 0.004$): the effect of Question Type differed across the three age groups (Fig. S2). Pairwise contrasts performed at each age group revealed that the log odds of getting the “Where does Sally think her ball is?” question correct was significantly greater than the log odds of getting the “Where will Sally look?” question correct among 4-year-olds ($z = 4.438, p < 0.001$) and 5-year-olds ($z = 3.785, p < 0.001$), but not among 3-year-olds ($z = 0.495, p = 0.62$).

More critically, we found a significant main effect of Condition ($\chi^2(1) = 7.136, p = 0.008$): the log odds of providing a correct response was significantly greater for the *Mean Anne* condition than for the *Nice Anne* condition (Fig. 1). Entering age as a continuous variable revealed a similar pattern of results: a significant main effect of Condition (see Supplementary Material). We also restricted our analyses to participants who responded to the question “Is Anne a nice girl or not a nice girl?” in a manner congruent with the condition to which they were assigned; this question served as a comprehension check, but excluding people who did not get this question correct did not change the general pattern of results (Supplementary Material).

Even though the interaction between Condition and Age Category was not significant, we nevertheless performed contrasts examining the difference between conditions at each Age Category and for each Question Type. For the question, “Where does Sally think her ball is?”, the difference between *Mean Anne* and *Nice Anne* was significant for 3-year-olds ($z = 1.997, p = 0.046$) but not for 4-year-olds ($z = -0.327, p = 0.74$) or for 5-year-olds ($z = 0.564, p = 0.57$). On the other hand, for the question, “Where will Sally look?”, the difference between *Mean Anne* and *Nice Anne* was significant for 4-year-olds ($z = 2.568, p = 0.01$) but not for 3-year-olds ($z = 1.069, p = 0.29$) or for 5-year-olds ($z = 1.260, p = 0.21$). These results reveal that children are more likely to respond correctly to questions about beliefs in competitive contexts than cooperative contexts at age 3 and more difficult questions about beliefs and behavior in competitive contexts than cooperative contexts at age 4.

Fig. 1. Proportion of responses that are correct broken down by Age Category, Condition, and Question Type. Error bars denote 95% CIs.

Study 2

Methods

Procedure

In Study 2, participants were introduced to a two-person game involving stickers, where the goal of the game was to get as many stickers as possible. Each participant was assigned to either the *Competition* condition or the *Cooperation* condition (see complete script in Supplementary Material). For both conditions, the participant was instructed to hide two stickers in one of two cups while a second player (a second experimenter, hereafter referred to as E2) had her eyes closed. The participant was instructed to respond however he or she wanted (e.g., by

pointing to either Cup #1 or Cup #2) when E2 opened her eyes and asked the participant where the stickers were. E2 would then make a guess as to where the stickers were solely based on the participant's response. In the *Competition* condition, only one person won stickers at a time: if E2 guessed correctly, she kept both stickers, but if she guessed incorrectly, the participant got to keep both stickers. In the *Cooperation* condition, both players could win stickers at the same time: if E2 guessed correctly, neither player got any stickers, but if she guessed incorrectly, the participant and E2 each got to keep one of the two stickers. In order to succeed on either task, the participant would have to plant a false belief in E2's mind. Each participant played four rounds of this game; thus, the participant had the opportunity to win up to 8 stickers in the *Competition* condition and up to 4 stickers in the *Cooperation* condition.

We included two additional conditions for the 4-year-old group to address a potential concern: that a difference in performance between the *Competition* and *Cooperation* conditions could be driven the difference in the maximum number of stickers a person could win (8 stickers versus 4 stickers). Participants may be more motivated to plant a false belief in another's mind when faced with a bigger prize (e.g., more stickers). Thus, we included a condition in which participants had the opportunity to win up to 4 stickers in the *Competition* condition and another in which participants could win up to 8 stickers in the *Cooperation* condition (see scripts in Supplementary Material). Because we expected any potential difference to emerge around 4 years of age, as predicted by prior work, we recruited only 4-year-olds for these two conditions.

For the 3-year-olds, we introduced an additional control condition (*Pompom* condition) to address the concern that poor performance on this task among this age group could be attributed to difficulties with pointing. In this condition, 3-year-olds were instructed to place pompoms in front of one of the two cups (in lieu of pointing to the cup) when responding to E2's question of

where the stickers were (see script in Supplementary Material). No difference in performance was found for the pompom versus non-pompom condition ($\chi^2(1) = 0.140, p = 0.71$), indicating that the added step of pointing does not negatively affect performance on this task. In our main analyses, we include data from both the *Pompom* and *Non-Pompom* conditions.

Analyses

Analyses were conducted in R (version 3.3.3; R Core Team, 2015). Responses were analyzed using Generalized Linear Models with proportion data. We were primarily interested in whether the proportion of stickers won depended on age and condition; our full model included the following predictor variables: Condition (cooperation or competition), Age Category (three, four, or five), and Gender (male or female). We also examined the two-way interaction between Condition and Age Category. To assess the importance of our predictors of interest, we performed likelihood ratio tests (LRTs) and examined whether the model including a given term provided a significantly better fit to the data than the model without that term.

Results

Analyses revealed no interaction between Condition (cooperation or competition) and Age Category ($\chi^2(2) = 3.5864, p = 0.1664$), suggesting that the effect of Condition did not vary across age group. Unsurprisingly, there was a significant main effect of Age Category ($\chi^2(2) = 242.25, p < 0.001$): the log odds of winning stickers was greater among older versus younger age groups. More importantly, and central to the present hypotheses, we found a significant main effect of Condition ($\chi^2(1) = 4.4441, p = 0.035$): the log odds of winning stickers was greater for the *Competition* condition than for the *Cooperation* condition. Entering age as a continuous

variable revealed the same pattern of results: significant main effects of Condition and Age (see Supplementary Material).

As in Study 1, even though the interaction between Condition and Age Category was not significant, we nevertheless performed contrasts examining the difference between Conditions at each Age Category. These preplanned contrasts revealed a greater difference for competition vs. cooperation among 4-year-olds ($z = 2.489, p = 0.0128$), but no difference between cooperation and competition among 3-year-olds ($z = 1.299, p = 0.1940$) or 5-year-olds ($z = 0.031, p = 0.9753$) (Fig. 2a). Together, the results of Study 2 suggest that children may be better at planting false beliefs in others when trying to achieve a competitive goal versus a cooperative goal, with this difference being most salient among 4-year-olds.

To examine whether performance in the task among 4-year-olds could be predicted by alternative factors such as the total possible number of stickers a participant could win (4 vs. 8), we examined the effects of Condition and Total Number of Possible Stickers by analyzing just the data with 4-year-olds (Fig. 2b). We did not see a significant effect of total possible number of stickers ($\chi^2(1) = 2.4572, p = 0.117$), and, more importantly, we still found a similar, albeit marginal, effect of Condition after controlling for Total Number of Possible Stickers ($\chi^2(1) = 3.3141, p = 0.069$).

Fig. 2. Performance on the game. Proportion of stickers won, (a) broken down by Age Category and Condition, (b) broken down by Condition and Total Number of Possible Stickers for the 4-year-old age group, and (c) depicted as a histogram broken down by Age Category and Condition. Error bars denote 95% CIs.

Comparisons between Study 1 and Study 2

Methods

Analyses

To examine whether Studies 1 and 2 are tapping into the same ToM construct, we tested whether success in the task for Study 1 could predict success in a different task (Study 2). This is a question we were able to address with the current dataset given that a large subset of our participants completed both studies. Analyses were performed using Generalized Linear Models and only used data from participants who completed both Study 1 and Study 2 ($N = 504$). The response variable was proportion of stickers won in Study 2. Predictor variables included performance in Study 1 (1=correct, 0=incorrect), Condition (Cooperation, Competition), Age Category (3s, 4s, 5s), Gender, the interaction between Condition and Age Category, and the interaction between performance in Study 1 and Age Category.

Results

There was a significant interaction between performance in Study 1 and Age Category ($\chi^2(2) = 13.104, p = 0.001$), with contrasts revealing significantly greater log odds of winning stickers in Study 2 for 3- and 4-year olds who answered correctly in Study 1 than for 3- and 4-year olds who answered incorrectly in Study 1 (3s: $z = 5.156, p < 0.001$; 4s: $z = 4.187, p < 0.001$). The difference among 5-year olds was not significant ($z = 1.200, p = 0.23$). These results suggest that performance in Study 1 significantly predicted performance in Study 2 among 3- and 4-year olds but not among 5-year olds.

General Discussion

Two studies reveal greater understanding of false beliefs (Study 1) and better application of such understanding (Study 2) for competitive versus cooperative contexts in preschool children. In Study 1, we tested children's false belief understanding using a novel variant of a

classic false belief task, tapping into children's abilities to understand people's mental states from the perspective of a third-party observer. In Study 2, we tested children's abilities to plant false beliefs in another's mind, tapping into children's abilities to use mental state information to guide their own behavior. We found a main effect of Condition in both tasks: the log odds of providing a correct response (Study 1) or winning stickers (Study 2) was greater for competitive contexts than for cooperative contexts. In short, we see the basic pattern of results as predicted by evolutionary theories derived from non-human primate work positing better ToM for competition than cooperation.

If ToM evolved to support competitive aims, people may be more attuned to the minds of those they consider to be potential opponents, even if they never actually end up interacting with them. Interestingly, though, in Study 1, participants were not making inferences about Mean Anne; rather, they were making inferences about Sally, who was neither a threat nor an opponent. An alternative possibility is that competitive contexts may trigger ToM such that people are more likely to reason about all minds related to the specific situation. Though our data don't speak directly to this alternative possibility, the results of Study 1 support the idea that children may be more generally attuned to minds in competitive contexts and not specifically to the minds of individual competitors.

What might the observed difference between competition and cooperation reflect? One uninteresting possibility is that the present cooperation conditions make greater processing demands than the competition conditions. That is, better performance in the competition conditions may result from greater difficulty in processing the cooperation conditions. For example, planting a false belief in someone's mind for cooperative reasons (Study 2) might seem unintuitive and unrealistic to our participants. We address this criticism in two ways. First,

common activities such as telling white lies or throwing surprise parties also require the ability to plant false beliefs in another's mind for cooperative aims, and indeed, preschool children demonstrate the ability to understand surprises (Hadwin & Perner, 1991; MacLaren & Olson, 1993; Wellman & Banerjee, 1991). Second, this criticism doesn't apply to Study 1, where we nevertheless find condition differences. Moreover, we find consistencies in performance across the two ToM tasks, suggesting that Study 1 and Study 2 tap into the same cognitive capacity. Thus, we believe we are capturing differences between competition and cooperation, rather than superficial task differences.

Whether condition differences remain stable over time is another question. While condition differences appear between ages 3 and 4 for Study 1 and at age 4 for Study 2 (possibly reflecting greater task difficulty for Study 2 as compared to Study 1), no condition difference emerges at age 5 in either study. These results suggest that any specific ToM advantage for competition may emerge when ToM first comes online but then may diminish over time, at least in the context of the present tasks—a suggestion that converges with our prior work showing that brain regions implicated in ToM are recruited to a similar extent for cooperation and competition in adults but these regions nevertheless encode differences relevant to ToM between the two contexts (Tsoi et al., 2016). However, the extent to which this diminished advantage can be attributed to schooling and greater exposure to perspective-taking in cooperative contexts (e.g., sharing with others in school settings) is unclear.

In short, our finding that preschool children show better understanding of false beliefs and are better able to apply that understanding in competitive vs. cooperative contexts contributes to the current debate regarding the function of ToM. Moreover, this work challenges

researchers' longstanding treatment of ToM as a unitary process and urges people to treat ToM as more multifaceted.

Author Contributions

L.Y., A.S.B., K.H., and A.W. developed the study concept and contributed to the study design. Testing and data collection was performed by A.S.B. L.T. analyzed the data and interpreted the results. L.T. drafted the manuscript, and A.S.B., K.H., A.W., and L.Y. provided critical revisions. All authors approved the final version of the manuscript for submission.

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Script for Study 1

Nice Anne Condition

Hi (child's name)! Let me introduce you to some people.

This is Sally (Sally waves), and this is Anne (Anne waves). Sally is playing with her favourite ball (act playing with ball) when her mom calls her out to lunch. Sally has to go, so she runs off, dropping her ball in the basket on the way out (act dropping ball in basket).

Now Anne sees where Sally put her favourite ball and knows that the ball is supposed to go in the closet, and NOT in the basket. Anne thinks that Sally must have been in such a hurry that she put her ball in the wrong place! Anne is a very nice girl, so she wants to help Sally by moving the ball to the closet. Anne goes and gets the ball out of the basket, and to help Sally, puts it away in the closet. That was very nice. Now Sally comes back after lunch and wants to find her ball.

Where will Sally look?

Where does Sally think her ball is?

Should Anne and Sally be friends?

Is Anne a nice girl or not a nice girl?

Is Sally a nice girl or not a nice girl?

Mean Anne Condition

Hi (child's name)! Let me introduce you to some people.

This is Sally (Sally waves), and this is Anne (Anne waves). Sally is playing with her favourite ball (act playing with ball) when her mom calls her out to lunch. Sally has to go, so she runs off, dropping her ball in the basket on the way out (act dropping ball in basket).

Now Anne sees where Sally put her favourite ball and knows that Sally LOVES to play with it. Anne thinks that Sally must have been in such a hurry that she will definitely come back after lunch to play with her ball again. Anne is not a very nice girl, so she wants to trick Sally by moving the ball to the closet. Anne goes and gets the ball out of the basket, and to trick Sally, puts it away in the closet. That was not very nice. Now Sally comes back after lunch and wants to find her ball.

Where will Sally look?

Where does Sally think her ball is?

Should Anne and Sally be friends?

Is Anne a nice girl or not a nice girl?

Is Sally a nice girl or not a nice girl?

Script for Study 2

Competition Condition – 8 stickers

You like stickers right? Well, E2 likes stickers too. Let me tell you about this game. Ok (child's name), here is the game. The goal of the game is to get as MANY stickers as you each can. You try and get as many as you can, and she'll try and get as many as she can. You and E2 both like these stickers, but in this game, only ONE person can win stickers at a time.

To play the game, I'll ask E2 to close her eyes, and then you can hide two stickers in one of these cups. You can put the stickers in this cup, in this cup or in this cup, in any cup you like, but both stickers have to go in the same cup! Now, after you hide the stickers while E2 can't see you, I will tell E2 she can open her eyes, and she will ask you a question about where the stickers are, and you can tell her whatever you want to. Then E2 will guess where the stickers are.

Now here's how the game goes. If E2 guesses wrong, then YOU get to keep both the stickers, but if E2 guesses right, then SHE gets to keep both the stickers! Get it? If SHE finds the stickers, SHE gets to keep them, but if she DOESN'T find the stickers, then YOU get to keep them! So we'll play the game the same way every time- you always get to hide the stickers and E2 will ask you a question and then guess where they are. Ok, just to make sure you understand the rules. If E2 finds the stickers, who gets to keep them? If she doesn't find the stickers, who gets to keep them?

Great, ok. Remember, the goal of the game is to win as many stickers as you can! You can take home all the stickers you win.

E1 to E2: Ok E2, close your eyes! No peeking!

E1 to child: ok, hide the stickers! Did you hide them?

E1 to E2: Ok E2, you can open your eyes and ask (child's name) a question!

E2 to child: ok (child's name), now I'm going to ask you, can you show me where the stickers are?

If stickers are in the cup, E1: "there are the stickers!" and gives them to E2. "This time the stickers go to E2!"

If the stickers are not in the cup, E1: "Huh, no stickers", find the stickers and give stickers to the child, "This time the stickers go to you!"

E1: Great! Ok, remember, we want to have as many stickers to take home at the end of the game!

Cooperation Condition – 4 stickers

You like stickers right? Well, E2 likes stickers too. Let me tell you about this game. Ok (child's name), here is the game. The goal of the game is to get as MANY stickers as you each can. You try and get as many as you can, and she'll try and get as many as she can. You and E2 both like these stickers, and in this game, you can BOTH get stickers at the same time.

To play the game, I'll ask E2 to close her eyes, and then you can hide two stickers in one of these cups. You can put the stickers in this cup, in this cup or in this cup, in any cup you like, but both stickers have to go in the same cup! Now, after you hide the stickers while E2 can't see you, I will tell E2 she can open her eyes, and she will ask you a question about where the stickers are, and you can tell her whatever you want to. Then E2 will guess where the stickers are.

Now here's how the game goes. If E2 guesses wrong, then each of you gets to keep one sticker! But if E2 guesses right, then NEITHER of you gets any stickers and they go back in the box! Get it? If SHE finds the stickers, no one gets ANY stickers, but if she DOESN'T find the stickers, then you EACH get to keep one!

So we'll play the game the say way every time- you always get to hide the stickers and E2 will ask you a question and then guess where they are. Ok, just to make sure you understand the rules. If E2 finds the stickers, who gets to keep them? If she doesn't find the stickers, who gets to keep them?

Great, ok. Remember, the goal of the game is to win as many stickers as you can! You can take home all the stickers you win.

E1 to E2: Ok E2, close your eyes! No peeking!

E1 to child: ok, hide the stickers! Did you hide them?

E1 to E2: Ok E2, you can open your eyes and ask (child's name) a question!

E2 to child: ok (child's name), now I'm going to ask you, can you show me where the stickers are?

If stickers are in the cup, E1: "there are the stickers! This time no one gets any stickers!"

If the stickers are not in the cup, E1 "Huh, no stickers", find the stickers and give stickers to the child and E2, "This time you both get a sticker!"

E1: Great! Ok, remember, we want to have as many stickers to take home at the end of the game!

Cooperation-Sheet condition for 4-year-olds – 8 stickers

In the *Cooperation* condition, participants could win at most 4 stickers, whereas in the *Competition* condition, participants could win at most 8 stickers. To address the concern that the number of total stickers that a participant could win may influence how well participants performed in the game, we added a different version of the *Cooperation* condition in which the total number of stickers one could possibly win matches the total number of stickers one could possibly win in the *Competition* condition (8 stickers).

Do you like stickers? Can I please get you to pick out 8 sticker sheets from this box?

You like stickers right? Well, E2 likes stickers too. Let me tell you about this game. Ok (child's name), here is the game. The goal of the game is to get as MANY sheets of stickers as you each can. You try and get as many as you can, and she'll try and get as many as she can. You and E2 both like these sheets of stickers, and in this game, you can BOTH get sticker sheets at the same time.

To play the game, I'll ask E2 to close her eyes, and then you can hide two sheets of stickers in one of these cups. You can put the sticker sheets in this cup, in this cup or in this cup, in any cup you like, but both sticker sheets have to go in the same cup! Now, after you hide the sticker sheets while E2 can't see you, I will tell E2 she can open her eyes, and she will ask you a question about where the stickers sheets are, and you can tell her whatever you want to. Then E2 will guess where the stickers sheets are.

Now here's how the game goes. If E2 guesses wrong, then each of you gets to keep one sticker sheet! But if E2 guesses right, then NEITHER of you gets any sticker sheets and they go back in the box! Get it? If SHE finds the sticker sheets, no one gets ANY sticker sheets, but if she DOESN'T find the sticker sheets, then you EACH get to keep one!

So we'll play the game the say way every time- you always get to hide the sticker sheets and E2 will ask you a question and then guess where they are. Ok, just to make sure you understand the rules. If E2 finds the sticker sheets, who gets to keep them? If she doesn't find the sticker sheets, who gets to keep them?

Great, ok. Remember, the goal of the game is to win as many sticker sheets as you can! You can take home all the sticker sheets you win.

E1 to E2: Ok E2, close your eyes! No peeking!

E1 to child: ok, hide the stickers sheets! Did you hide them?

E1 to E2: Ok E2, you can open your eyes and ask (child's name) a question!

E2 to child: ok (child's name), now I'm going to ask you, can you show me where the sticker sheets are?

If stickers are in the cup, E1: "there are the stickers! This time no one gets any sticker sheets!"

If the stickers are not in the cup, E1 "Huh, no sticker sheets", find the stickers and give stickers to the child and E2, "This time you both get a sticker sheet!"

Competition-Four Stickers condition for 4-year-olds – 4 stickers

In the *Cooperation* condition, participants could win at most 4 stickers, whereas in the *Competition* condition, participants could win at most 8 stickers. To address the concern that the number of total stickers that a participant could win may influence how well participants performed in the game, we added a different version of the *Competition* condition in which the total number of stickers one could possibly win matches the total number of stickers one could possibly win in the *Cooperation* condition (4 stickers).

The script was the same as the one for *Competition* condition – 8 stickers, but instead of facing the possibility of earning 2 stickers per round, participants faced the possibility of earning 1 sticker per round.

Pompom condition for 3-year-olds

Because we were concerned that difficulties with pointing among 3-year-olds could have affected their performance on the task, we introduced a control condition (*Pompom* condition) to

a subset of 3-year-olds. Instead of pointing to the cup of their choosing, participants in this condition placed a pompom in front of the cup.

E1 to E2: Ok E2, close your eyes! No peeking!

E1 to child: ok, hide the stickers! Did you hide them?

E1 to E2: Ok E2, you can open your eyes and ask (child's name) a question!

E2 to child: ok (child's name), now I'm going to ask you, can you show me where the stickers are by placing the pompom in front of the cup where the stickers are?

If stickers are in the cup, E1: "there are the stickers! This time no one gets any stickers!"

If the stickers are not in the cup, E1 "Huh, no stickers", find the stickers and give stickers to the child and E2, "This time you both get a sticker!"

E1: Great! Ok, remember, we want to have as many stickers to take home at the end of the game!

Participant Information

We recruited a total of 677 participants. Most participants were assigned to both Studies 1 and 2, and our predetermined goal of 60 participants per cell (roughly 30 per gender) was based on the cells in Study 2.

Study 1:

The final sample consisted of 537 participants (Table S1). Of the 643 participants that were recruited for Study 1, 106 were excluded due to: participant's age being outside our age range of interest (31), incompleteness of the task or declining to do the task (12), insufficient understanding of English (10), parental/other interference (9), being a part of experimenter pilot/training (8), lack of attention to the task (6), experimenter error (4), not understanding the task (4), having previously seen or completed the task (3), improper consent forms (2), having a developmental disorder (2), fussing out (2), or having data noted by the experimenter as unusable (12).

Table S1. Final sample breakdown by age, gender, and condition for Study 1

	Female	Male	Total
Mean Anne			
three	37	35	72
four	66	64	130
five	26	36	62
Nice Anne			
three	37	38	75
four	71	65	136
five	29	33	62
Grand Total	266	271	537

Study 2:

The final sample consisted of 541 participants (Table S2). Of the 662 participants that were recruited for Study 2, 121 were excluded due to: age outside our age range of interest (30), incompleteness of the task or declining to do the task (21), parental/other interference (11), insufficient understanding of English (9), lack of understanding of the task (9), lack of attention to the task (6), experimenter error (6), indications of not following task instructions (5), participant having previously seen or completed the task (3), invalid consent forms (2), participant having a developmental disorder (2), fussing out (2), being a part of experimenter pilot/training (2), or having data noted by the experimenter as unusable (13).

Table S2. Final sample breakdown by age, gender, and condition for Study 2

	Female	Male	Total
Competition			
three	48	38	86
four – 4 stickers	26	26	52
four – 8 stickers	39	30	69
five	27	34	61
Cooperation			
three	41	39	80
four – 4 stickers	35	30	65
four – 8 stickers	30	35	65
five	27	36	63
Grand Total	273	268	541

Study 1: Additional Analyses

Descriptive statistics for responses to questions in Study 1

In addition to the two main questions, “Where will Sally look?” and “Where does Sally think her ball is?”, we asked, “Should Anne and Sally be friends?”, “Is Anne a nice girl or not a nice girl?”, and “Is Sally a nice girl or not a nice girl?”. Proportion data for the latter three questions are depicted below (Fig. S1).

Fig. S1. Proportion of participants by response to auxiliary questions in Study 1, broken down by Condition and Age Category.

Breakdown of performance by Age Category and Question Type

Figure S2. Proportion of participants answering correctly by age group and question. Results are reported in the main text. Bars denote 95% CI.

Analyses limited to participants who responded in a congruent manner

The following analyses restricted the data to those who responded to the question “Is Anne a nice girl or not a nice girl?” in a manner congruent to the condition to which they were assigned. This question acted as a comprehension check, but excluding people who did not get this question correct did not change the general pattern of results.

Results were similar to those found in the main text with all usable data. Likelihood ratio tests revealed no significant three-way interaction between Condition, Question Type, and Age Category ($\chi^2(2) = 2.0941, p = 0.351$), no significant two-way interaction between Condition and Age Category ($\chi^2(2) = 2.0691, p = 0.3554$), a marginally significant two-way interaction between Condition and Question Type ($\chi^2(1) = 3.1647, p = 0.075$), and a marginally significant interaction between Question Type and Age Category ($\chi^2(2) = 5.4554, p = 0.065$).

More importantly for our hypotheses, the main effect of Condition remained significant ($\chi^2(1) = 13.717, p < 0.001$): the log odds of providing a correct response was significantly greater for the *Mean Anne* condition than for the *Nice Anne* condition.

Entering age as a continuous variable provided a similar pattern of results, revealing, once again, a significant main effect of Condition (see Supplementary section on Analyses with age as a continuous variable).

Analyses with age as a continuous variable

Because some models failed to converge, we dropped participant as a random effect from analyses using age as a continuous variable and analyzed the data using Generalized Linear Models instead of Generalized Linear Mixed Models.

With all usable data (data reported in the main text):

Entering age as a continuous variable did not affect the pattern of results found in the main text. Similar to results reported in the main text, likelihood ratio tests revealed no significant three-way interaction between Condition, Question Type, and Age ($\chi^2(1) = 1.0116, p = 0.3145$), no significant two-way interaction between Condition and Age ($\chi^2(1) = 0.682, p = 0.409$), and no significant two-way interaction between Condition and Question Type ($\chi^2(1) = 2.3335, p = 0.1266$). There was, again, a significant interaction between Question Type and Age Category ($\chi^2(1) = 8.8752, p = 0.003$): the effect of Question Type differed by age. Importantly, the main effect of Condition remained significant ($\chi^2(1) = 7.2893, p = 0.007$): the log odds of providing a correct response was significantly greater for the *Mean Anne* condition than for the *Nice Anne* condition.

With data limited to participants responding in a congruent manner:

Similar to results reported in the main text, likelihood ratio tests revealed no significant three-way interaction between Condition, Question Type, and Age ($\chi^2(1) = 0.73388, p = 0.3916$) and no significant two-way interaction between Condition and Age ($\chi^2(1) = 1.3816, p = 0.2398$). There was a marginally significant two-way interaction between Condition and Question Type ($\chi^2(1) = 3.1597, p = 0.07548$). There was, again, a significant interaction between Question Type and Age ($\chi^2(1) = 4.4642, p = 0.0346$): the effect of Question Type differed by age. Importantly, the main effect of Condition remained significant ($\chi^2(1) = 13.605, p < 0.001$): the log odds of providing a correct response was significantly greater for the *Mean Anne* condition than for the *Nice Anne* condition.

Study 2: Additional Analyses

Analyses with age as a continuous variable

Likelihood ratio tests revealed a significant main effect of Context ($\chi^2(1) = 6.2352, p = 0.013$) and a significant main effect of the Age category ($\chi^2(1) = 233.08, p < 0.001$): that is, the odds of receiving stickers was greater for the *Competition* condition than for the *Cooperation* condition, and the odds of receiving stickers increased with increasing age. This pattern of results is the same found for models with age entered as a categorical variable (see main text).