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The Role of Child Characteristics and Peer Experiences in the Development of Peer Cooperation

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Abstract

Cooperation with peers is challenging for young children, and there are large individual differences in the development of cooperation. The roles of child characteristics and peer experiences for peer interaction during free play have been studied extensively, but it is unclear which factors predict young children's successful cooperation at different points in development. In this study, 2-, 3-, and 4-year-old children were observed during a peer cooperation task. Both their interactive behavior and cooperation success were examined, and the association of these variables with child characteristics and peer experiences was explored. Results showed that successful peer cooperation increased with age. Moreover, early individual differences in peer cooperation were related to temperamental characteristics, and, among older children, the rate of cooperation was related to prior peer experience.

Keywords: cooperation; peers/peer relations; individual differences

Introduction

Cooperation with peers is important in children's daily lives, as everyday actions such as building a block tower together require successful cooperation. Peer cooperation is

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conceptualized as coordinated interaction between peers to reach a common goal (Brownell, Ramani, & Zerwas, 2006). For instance, cooperation requires the ability to regulate one's own behavior (Brownell, 2011; Meyer, Bekkering, Paulus, & Hunnius, 2010) and to predict and monitor the other person's behavior (Meyer, Hunnius, van Elk, van Ede, & Bekkering, 2011; Vesper, Butterfill, Knoblich, & Sebanz, 2010). The ability to cooperate with peers has been observed only incidentally in 18- or 19-month-old infants, whereas 23- to 30-month-old children have been shown to cooperate more effectively and quickly (Brownell & Carriger, 1990; Brownell et al., 2006). Although there are large individual differences when children begin to show signs of peer cooperation (Eckerman & Peterman, 2004), relatively little is known about the factors that influence cooperation in young children.

Despite a lack of studies on factors that influence cooperation, multiple aspects have been studied in relation to (not necessarily coordinated) peer interactions through observation of free play (e.g., Gevers Deynoot-Schaub, 2006; NICHD Early Child Care Research Network, 2008). These factors can be divided in two broad groups: child characteristics and peer experiences. Our main research question therefore addressed whether young children's cooperation capabilities are related to their individual characteristics and to their experiences with peers. We also examined how consistent such associations are across age. Insight on these issues will provide information about individual differences in cooperation across development and can inform ways to stimulate children's cooperation abilities.

Child Characteristics

Studies that examined child characteristics in relation to peer interaction during free play mainly focused on the role of gender and temperament (e.g., Hay, Caplan, & Nash, 2009). Also social competence is often related to peer interaction (e.g., Hawley, 2002; Webster-Stratton & Lindsay, 1999).

During free play, girls have been described to display more cooperative, mitigating, or positive behaviors, whereas boys tend to be more competitive and aggressive. This is found across development, during infancy (Gevers Deynoot-Schaub, 2006), toddlerhood (Lamb & Ahnert, 2006), and preschool years (Dodge, Coie, & Lynam, 2006; Holmes-Lonergan, 2003; Maccoby, 2002; NICHD Early Child Care Research Network, 2001).

Differences in temperament, such as children's activity level or their ability to regulate emotions, also influence early peer interaction (Hay et al., 2009). Although it seems commonly accepted that children with a difficult temperament face more problems in peer interaction than children who are easy-going (e.g., Gevers Deynoot-Schaub, 2006), the exact associations of the three main dimensions of temperament, negative affectivity, surgency, and effortful control with peer interaction have hardly been studied (see Rothbart & Bates, 2006). In school-age children, higher general activity (surgency) is related to lower levels of peer-rated prosocial behaviors (Serry et al., 2010). Negative affectivity seems to play a role in the amount of peer interaction in which children engage, as Williams, Ontai, and Mastergeorge (2007) found that infants with higher negative affectivity at 12–17 months showed more passive withdrawal from peer interaction 6 months later. Finally, a lack of effortful control may result in social problems, as effortful control allows children to shift attention from an immediate reward to the likely consequences of their behavior (Rothbart, Ahadi, & Hershey, 1994). Thus, it can be expected that less surgency and

negative affectivity, and more effortful control, are related to better interactions with peers in young children.

Social competence includes a broad range of competencies such as imitation and pretend play skills, empathy, emotional awareness, and prosocial behavior (Carter, Briggs-Cowan, Jones, & Little, 2003). A socially competent child is expected to be sensitive and empathic, engage in complex play, form friendships, and solve social problems (Howes, Matheson, & Hamilton, 1994). To our knowledge, there is only one study that related social competence in young children to their interaction behaviors with peers. Gevers Deynoot-Schaub and Riksen-Walraven (2006) found that social competence in 23-month-olds, but not in 15-month-olds, was related to more positive initiatives and more frequent interactions with peers.

Peer Experiences

Children's experiences with siblings and other peers provide a unique context to explore and practice interaction skills (Lamb & Ahnert, 2006; McCoy, Brody, & Stoneman, 1994). Previous research that examined how experience with peers is related to interactions with peers has focused on the experiences young children gain within their families (e.g., with siblings) as well as outside their family homes (e.g., in child care settings).

Although one might expect a positive influence of peer experiences on the quality of peer interaction, findings on the effects of siblings have been inconsistent (Hay et al., 2009). For example, Downey and Condron (2004) concluded that preschool children growing up with at least one sibling indeed exhibited better interpersonal skills with peers than children without a sibling. However, Hay, Castle, Davies, Demetriou, and Simson (1999) found that toddlers with older siblings were less likely to share with peers than toddlers with younger siblings.

With respect to child care attendance, studies have reported both positive and negative associations of child care with the quality of peer interaction. On the one hand, associations have been found of child care attendance with increased complexity of social interactions, positive affect, and sociability (Loeb, Bridges, Bassok, Fuller, & Rumberger, 2007; NICHD Early Child Care Research Network, 2001, 2002b, 2008). On the other hand, negative correlates of child care attendance also have been reported, such as externalizing behavior problems, in toddlers (Loeb et al., 2007) as well as preschoolers (NICHD Early Child Care Research Network, 2002a). The intensity of child care attendance might play a role in this respect, as the association of child care with behavior problems was more pronounced for children who entered child care at an earlier age and for children who spent more hours per week in child care (Loeb et al., 2007).

Child Characteristics and Peer Experiences as Predictors of Cooperation

The above overview of the literature suggests a significant contribution of both child characteristics and peer experiences to the quality of peer interaction during free play. An important question is whether these factors are also related to the development of peer cooperation as an especially challenging form of peer interaction. When cooperating, interactions have to be coordinated to reach a common goal (Brownell et al., 2006). In order to examine the associations of children's characteristics and peer experiences with the quality of interactive behavior during cooperation and with

cooperation success, we studied same-gender dyads of 2-, 3-, and 4-year-olds during a cooperation task. Children's social competence and temperament were assessed using parent reports. To examine children's experiences with peers, we noted whether they had siblings and attended child care. We expected that the quality of interactive behavior during a peer cooperation task would be positively related to cooperation success on the task. Moreover, we examined how child characteristics and peer experiences were related to the quality of interactive behavior and cooperation success. We expected an increase in cooperation success with age given increased competence in more difficult cooperation tasks during the third year of life. To examine developmental changes, we examined how child characteristics, peer experiences, and interactive behavior predicted increased cooperation competence across age.

Method

Participants

The final sample consisted of 126 2-year-old children ($M = 27.97$ months, standard deviation (SD) = .32), 70 3-year-old children ($M = 40.21$, $SD = .28$), and 70 4-year-old children ($M = 55.14$, $SD = 4.12$). The 2-year-old group was larger, as those children were part of a longitudinal study on cooperation development. Of all children, 53% were boys. There was no age group difference in the ratio of girls to boys. The 2- and 3-year-old children were selected from a sample of families who were part of a database of parents in the Nijmegen area (a Dutch city with approximately 165 000 inhabitants) and who were willing to participate with their child in research. Two schools from the same area participated with classes of 4-year-olds.

The 2- and 3-year-old children were invited to the lab and randomly paired with an unfamiliar same-gender peer. The 4-year-old children were tested at their school outside the classroom and randomly paired with a same-gender peer from another class. Some children had seen their dyad partner before, but only two dyads had actually played together previously. Most children were Dutch and came from mixed socioeconomic backgrounds. Parents were informed about the study and signed a consent form. Three 2-year-olds and two 3-year-olds did not show up for their appointment; therefore, the other children of these dyads were excluded from the study. Furthermore, dyads were excluded if one child never got involved in the task, as the other child in these dyads did not have the possibility to cooperate successfully. This resulted in the exclusion of 26 2-year-old dyads and 8 3-year-old dyads. Questionnaires of 16 children were missing, but those children were kept in the sample, because the questionnaires of their dyad partners were available.

Peer Cooperation Task

The peer cooperation task was based on Warneken, Chen, and Tomasello's (2006) double-tube task. The setup consisted of two 1-m tubes mounted in parallel on a box with a 45 deg incline (see Figure 1). The two children were shown a Playmobil figure (geobra Brandstätter GmbH & Co.KG, Zirndorf, Germany) in a swimsuit and a small swimming pool. They were instructed that the figure wanted to go through the sliding tube to the swimming pool. The tubes were too long for one child to simultaneously hold the swimming pool and insert the figure into the tube.

Two experimenters demonstrated the task twice in person to the 2- and 3-year-olds. The 4-year-olds received the instructions via a pre-recorded video. After the

Figure 1. Children Cooperating Successfully on the Peer Cooperation Task.

demonstration, the Playmobil figure and swimming pool were put on the floor so that both children were able to play with the materials. When children did not choose the same tube, they were reminded verbally (up to three times) that the figure wanted to go to the pool. Subsequently, children were only stimulated to play by saying that the figure wanted to slide again. If a child did not participate in the game during the first 2 min or five sliding trials of their partner, the experimenters performed the task together with both children twice. During these practice trials, one child was given the role of holding the swimming pool and the experimenter helped to hold the swimming pool below one of the tubes, whereas the other child was stimulated to insert the figure into one of the tubes. If thereafter a child still did not get involved, the task was terminated after three more attempts of the dyad partner. Dyads with five or fewer slides of the figure were excluded from the study.

Procedure

Parents received questionnaires by mail and handed them in during the session or returned them by mail. The session started with 5–30 min of free play during which the children could familiarize themselves to each other and the experimenters. The duration of free play varied across age groups, as older children needed less time for this phase. The introductory phase was followed by the peer cooperation task for 5 min. Parents were instructed to minimize their interactions with the child and, if the child was clinging to the parent to respond in ways to stimulate play without helping them with the task. The cooperation task was terminated once due to too much interference of a parent. Parents were not present during the sessions of the 4-year-olds, as these took place at school. Overall, sessions lasted for 20–45 min. The 2- and 3-year-old children received either a book or 10 Euros ‘for their piggy bank’ as a thank you for

participation. Teachers of the 4-year-olds were offered a picture book for the participation with their class. The entire session was videotaped with two cameras to allow offline coding.

Measures

Cooperation attempts were coded as successful if both the child who inserted the figure into the tube and the child who held the swimming pool chose the same tube. Cooperation attempts were coded as unsuccessful if children chose different tubes or if one child performed the task alone, resulting in the figure falling on the floor. For each trial (defined as a 'slide' of the figure through the tube), it was coded whether cooperation was successful or not. To control for the total number of attempts, the data were transformed into a percentage of success on the task for each dyad. The recordings of 18 of the 140 dyads (13%) were double-coded by a second observer. Cohen's Kappa (K) was .92 on average (range .76–1.00).

The interactive behavior of each child was coded separately using a coding scheme based on Hunnius, Bekkering, and Cillessen (2009). Behaviors were divided into *affiliative* behaviors that supported the interaction and *antagonistic* behaviors that obstructed it (see Table 1). Repeated occurrence of the same behavior category was coded as a new occurrence if the child had stopped the behavior before showing it again, and in the case of verbal behavior, once for each utterance. The first author trained eight independent coders in the coding scheme. Coders were regularly monitored, as one in six videos was double coded blindly by the trainer. They had to have more than 70% agreement based on both frequency and sequence of codes within a 3-s distance to allow the coder to continue, which was always the case ($K = .75$, range .45–1.00).

Child characteristics and peer experiences were measured through parent questionnaires. Social competence was measured with the Dutch version of the competence scale of the Infant Toddler Social Emotional Assessment (ITSEA; Carter & Briggs-Cowan, 2000a, 2000b). This scale has 37 items rated on a 3-point scale, such as 'Takes turns when playing with others'. The ITSEA is reliable (Carter & Briggs-Cowan, 2000a) and is indicative of children's social competence in daily life, as it is related to independent evaluator ratings of observed child behavior (Carter et al., 2003). Originally, the scale was developed for 12- to 36-month-old infants. For the sake of comparability between age groups, we administered it also to the 3- and 4-year-old participants. Nine items were slightly adapted to fit the older age group. For example, 'Quiets down when you say "Shh"' was changed into 'Quiets down when you ask'. In our sample, the internal consistency of scale for the 2-year-olds was .84, and the internal consistency of the adapted scale was .86 for the 3-year-olds and .84 for the 4-year-olds.

Temperament was measured for the 3- and 4-year-olds with the very short form of the Childhood Behavior Questionnaires (CBQ; Putnam & Rothbart, 2006) and for the 2-year-olds with the very short form of the Early Childhood Behavior Questionnaire (ECBQ; Putnam, Jacobs, Garstein, & Rothbart, 2010). The questionnaires included three 12-item scales: negative affectivity, surgency, and effortful control. All items were rated on a 7-point scale. Reliabilities of both the CBQ and ECBQ short forms are good and fit a three-factor model (Putnam & Rothbart, 2006; Putnam et al., 2010). This measure was validated by comparing it to scores of children's behavior in standardized lab tests for temperament (Gagne, Van Hulle, Aksan, Essex, & Goldsmith,

Table 1. Coding Scheme for the Interactive Behavior during the Peer Cooperation Task

Affiliative behaviors	
Sharing	Hands over the Playmobil figure/swimming pool to the peer
Helping	Gives task directions, helps the peer with the task, or prepares peer that the figure is going to slide
Directing	Directs the behavior of the peer by assigning a role to the peer
Ask material/ procedure	Asks for figure/swimming pool, asks for a turn, or asks what the peer wants
Ask for help	Asks the peer for help
Agree	Agrees verbally to a question of the peer
Positive response	Responds by laughing, applauding or making positive comments to the behavior of the peer or to the successful cooperation
Antagonistic behaviors	
Taking away	Snatches away the figure/swimming pool out the hands of the peer, or aims to do so
Competing	Races against the peer to get the figure or the swimming pool
Claiming/hinder	Claims one of the objects, refuses to share an object (by turning away or hiding the object), hinders the peer to insert the figure into the tube by placing the hands over the tube
Protesting	Protests as a reaction to peer's behavior or question
Aggression	Aggressive acts toward the peer or material (e.g., pushing, throwing the figure on the ground)
Neglecting	Does not respond to approaches (e.g., sharing), directions or a question of the peer

2011). We constructed Dutch versions of the questionnaires using Behling and Law's (2000) procedure of translation and back translation until agreement was reached. In our sample, internal consistencies of the surgency scale for 2-, 3-, and 4-year-olds, respectively, were .67, .63, and .58; of negative affect were .75, .55, and .73; and of effortful control were .78, .71, and .73.

Parents indicated the number and age of the child's siblings, and whether and how many days per week the child attended child care. As some children attended multiple forms of care, all formal child care forms were combined to determine the total number of days a week each child attended care. Informal child care with little or no peer contact (such as a private nanny or baby sitter) was not taken into account. In the Netherlands, children commonly attend child care for maximally 11 h/day on several weekdays from the age of 3 months on. It is less common that a child attends care for five full days per week (te Riele, 2006).

Results

Age Differences in Cooperation Success

During 5 min of play, the 2-year-old dyads let the Playmobil figure slide through the tube on average 13.3 ($SD = 4.6$) times. The 3-year-old and 4-year-old dyads did so 17.2 ($SD = 4.8$) and 18.5 ($SD = 4.0$) times, respectively. The three age groups were compared on the percentage of coordinated trials. Successful cooperation made up 22% ($SD = 26\%$) of the trials for the 2-year-old dyads; 3- and 4-year-old dyads performed better with average scores of 63% ($SD = 30\%$) and 79% ($SD = 14\%$), respectively. The ANOVA on success was significant, $F(2, 132) = 68.56, p < .001, \eta^2 = .51$. *Post hoc* Bonferroni analyses indicated that 3-year-olds performed better than 2-year-olds, $p < .001$, and 4-year-olds performed better than both 2-year-olds and 3-year-olds, $p < .001$ and $p = .03$, respectively.

Interactive Behavior

Table 2 shows the average number of individual affiliative and antagonistic behaviors per minute by age group. As both dyad partners might have influenced each other's behavior during the task, intraclass correlations (ICC) were calculated for the total amounts of affiliative and antagonistic behaviors. For 2-year-olds, the amount of affiliative behaviors of the dyad partners were positively related, $r = .35, p = .05$. Intraclass correlations for antagonistic behaviors were positive and significant for the 2- and 3-year-olds, $r = .73, p < .001$, and $r = .47, p = .03$, respectively, and marginally significant for the 4-year-olds, $r = .43, p = .05$.

Child Characteristics and Peer Experiences

Table 3 shows that older children were more socially competent, with *post hoc* Bonferroni tests indicating a difference between 2- and 4-year-olds ($p = .01$). Age groups also differed in surgency and negative affectivity, with a significant difference between 2- vs. 3- and 4-year-olds ($ps < .001$). There was also an age difference in the number of children with a sibling, with a significant difference between 2- and 4-year-olds ($p = .02$). There were no age differences in effortful control or days attending child care.

Table 4 shows that surgency and negative affectivity were related to interactive behavior in the task. Moreover, among 4-year-olds social competence was related to affiliative behavior, child care attendance, and percentage of cooperation success.

Associations with Affiliative Behavior and Cooperation Success

To examine the associations of child characteristics and peer experiences with interactive behavior and cooperation success, structural equation modeling was conducted using AMOS 20.0 (IBM SPSS, Armonk, NY, USA). We used the mutual influence model to examine the effects of the predictors on the outcomes while taking the dyadic structure and mutual influence between the dyad partners into account (Kenny, Kashy, & Cook, 2006). Hereby, means, variances, covariances, and paths were set equal between dyad members, as the two children in each dyad were interchangeable. Multi-group modeling for affiliative and antagonistic behaviors separately was used to test whether associations differed between age groups.

Table 2. Frequency of Interactive Behavior per Minute as Coded per Individual and Intraclass Correlations

	2-Year-olds (<i>N</i> = 136)		3-Year-olds (<i>N</i> = 74)		4-Year-olds (<i>N</i> = 70)					
	Frequency (<i>SD</i>)	ICC	Frequency (<i>SD</i>)	ICC	Frequency (<i>SD</i>)	ICC				
Affiliative behaviors	1.20	(1.17)	.35*		2.14	(2.20)	.17	3.34	(2.19)	.33
Sharing	.20	(.33)			.23	(.37)		.43	(.45)	
Helping	.44 ^a	(.57)			.41	(.67)		.33	(.35)	
Directing					.57	(1.05)		.89	(1.01)	
Ask material/procedure	.17	(.30)			.14	(.24)		.33	(.42)	
Ask for help	.12	(.26)			.05	(.13)		.01	(.04)	
Agree	.08	(.20)			.05	(.12)		.18	(.30)	
Positive response	.18	(.37)			.68	(.86)		1.17	(1.08)	
Antagonistic behaviors	1.68	(1.41)	.73*		1.04	(.93)	.47*	1.11	(.96)	.43
Taking away	.25	(.41)			.13	(.20)		.18	(.24)	
Competing	.78	(.61)			.15	(.20)		.09	(.16)	
Claiming/hinder	.43	(.70)			.41	(.47)		.41	(.46)	
Protesting	.15	(.31)			.25	(.41)		.35	(.51)	
Aggression	.04	(.13)			.03	(.11)		.01	(.06)	
Neglecting	.04	(.14)			.06	(.21)		.07	(.23)	

Note: ICC = intraclass correlation; *SD* = standard deviation.

^a For the 2-year-olds the categories helping and directing were taken together, as at this age children's vocabulary was not developed enough to make a distinction between helping and directing.

* $p < .05$.

Table 3. Descriptive Statistics of Child Characteristics and Peer Experience Variables and Test of Age Differences

	2-Year-olds (<i>N</i> = 125)		3-Year-olds (<i>N</i> = 65)		4-Year-olds (<i>N</i> = 59)		<i>F</i> (2,248)	<i>p</i>	η^2
	Mean (<i>SD</i>)	Mean (<i>SD</i>)	Mean (<i>SD</i>)	Mean (<i>SD</i>)	Mean (<i>SD</i>)	Mean (<i>SD</i>)			
Social competence	1.55	(.21)	1.60	(.22)	1.65	(.19)	4.41	.01	.03
Temperament									
Surgency	4.95	(.63)	4.38	(.65)	4.14	(.60)	39.94	<.001	.25
Negative affectivity	2.61	(.68)	3.17	(.83)	3.45	(.75)	30.16	<.001	.20
Effortful control	4.98	(.63)	5.00	(.76)	5.07	(.66)	.35	.70	<.01
Siblings	.62	(.49)	.77	(.43)	.81	(.39)	4.66	.01	.04
Days child care	1.85	(.89)	2.15	(.82)	1.86	(.82)	2.85	.06	.02

Note: *SD* = standard deviation.

* $p < .05$.

Figure 2 presents the best fitting models resulting from the model with affiliative behavior. For all age groups, there were significant effects of surgency, $\beta = .21$, $p < .001$, and negative affectivity, $\beta = -.14$, $p = .009$, on affiliative behavior. More surgency and less negative affectivity were related to more affiliative behavior. Girls showed more affiliative behaviors than boys, $\beta = .21$, $p = .02$. There was also an effect of effortful control on cooperation success, $\beta = .08$, $p = .01$. More effortful control was related to more cooperation success. For the 2- and 3-year-olds, more affiliative behavior predicted more cooperation success, $\beta = .21$, $p < .001$ (see Figure 2a). For the 4-year-olds, there was a positive effect of child care on cooperation success, $\beta = .16$, $p < .001$ (see Figure 2b). For cooperation success, the best fitting models explained 8.6%, 18.6%, and 39.6% of the variance for the 2-, 3-, and 4-year-old groups, respectively. For affiliative behavior, the best fitting models explained 15.8%, 5.2%, and 5.5%, respectively.

To attain the best fitting models, we started from the most constrained model, due to power problems and no specific hypothesis about age differences. We began with a pretest with all paths set to zero and consecutively tested whether intercepts, means, variances, and covariances differed between age groups. Results showed that the model was best with the means for effortful control, child care, and gender, all variances except for negative affectivity and the error terms, and all covariances restricted across age. Moreover, part of the covariances could be set to zero.

With these restrictions from the pre-test, in step 1 we examined the path from affiliative behavior to cooperation success (Figure 3, path f/f'). Models without this path or with this path restricted across age did not fit better than a model in which this path had a separate value for each age group, $\chi^2(3) = 11.28$, $p = .01$, and $\chi^2(2) = 8.58$, $p = .01$, respectively. Thus, the association between affiliative behavior and cooperation success differed across age.

In step 2, we tested for mutual influence of a child's affiliative behavior on the affiliative behavior of the dyad partner (Figure 3, path e/e'). This was not the case, as the model with only the path between affiliative behavior and cooperation success was better than models with an additional mutual influence either equal across age, $\chi^2(1) = 2.76$, $p = .10$, or unequal across age, $\chi^2(3) = 3.81$, $p = .28$.

Table 4. Correlations of Child Characteristics and Peer Experience Variables with Cooperation Success and Number of Affiliative and Antagonistic Behaviors per Minute by Age Group

	2-Year-olds (<i>N</i> = 126)			3-Year-olds (<i>N</i> = 65)			4-Year-olds (<i>N</i> = 59)		
	Success	Affiliative	Antagonistic	Success	Affiliative	Antagonistic	Success	Affiliative	Antagonistic
Social competence	.08	.08	.01	.14	.06	.07	.11	.30*	.20
Temperament									
Surgency	-.03	.29*	-.01	.02	.09	.16	-.04	.35*	.26*
Negative affectivity	.00	-.14	-.18*	-.17	-.11	.04	-.16	-.25	-.20
Effortful control	.01	.02	.05	.21	.08	-.12	.21	-.03	-.13
Siblings	.05	.02	-.06	-.09	.13	.03	.02	.11	.13
Days child care	-.09	-.01	-.02	-.13	-.02	-.04	.29*	.32*	.04

Note: * $p < .05$.

Figure 2. The Models with the Best Fit of the Association between Child Characteristics and Peer Experiences with Affiliative Behavior and Cooperation Success for 2- and 3-year-olds (a) and for 4-year-olds (b). All Covariances, Insignificant Paths, and the Paths between Child Care and Cooperation Success and Affiliative Behavior are Kept in the Model, but Restricted to Zero.

Figure 3. Simplified Dyadic Model of the Association between Independent Variables (IV) and Interactive Behavior and Cooperation Success, with a₁ Assigned to Variables for the First Child in the Dyad, a₂ for Variables of the Second Child in the Dyad, and a_{1,2} for Dyadic Variables. Paths with Equal Letters are Set Equal between Dyad Members, with the Letter without Accent Indicating the Path for Child 1, and with Accent Indicating the Path for Child 2.

In step 3, model fit was tested for each independent variable separately (Figure 3, path a-d/a'-d'). Models with a fixed parameter across age for the paths from surgency, negative affectivity, and gender to affiliative behavior led to a better fit than models with separate values by age or without these paths (see Table 5). For surgency and gender, the models with separate values by age also fit better than the models without these paths, but the models with the paths restricted across age fit better, $\chi^2(2) = 2.63$, $p = .27$, and $\chi^2(2) = 2.45$, $p = .29$, respectively. The model fit was also better with a separate value for each age group for the paths from child care to cooperation success. The fit of the model with an effect of effortful control on cooperation success when the path was equal across age showed a trend. The path of social competence to affiliative behavior also showed a trend, with a better model fit for the model with the path equal

Table 5. Chi-squared Difference Values for the Models with an Independent Variable with Paths Restricted or Unrestricted Across Age

Independent variable	Dependent variable	Affiliative model		Antagonistic model	
		Restricted across age	Unrestricted across age	Restricted across age	Unrestricted across age
Social competence	Cooperation success	2.06	2.07	2.65	3.17
Social competence	Interactive Behavior	2.84 [†]	6.51 [†]	1.31	2.22
Surgency	Cooperation success	.59	.83	.10	.12
Surgency	Interactive Behavior	16.31*	18.94*	3.15 [†]	5.92
Negative affectivity	Cooperation success	2.13	4.49	2.56	3.91
Negative affectivity	Interactive Behavior	5.44*	6.80 [†]	1.78	6.84 [†]
Effortful control	Cooperation success	3.43 [†]	5.02	3.95*	5.46
Effortful control	Interactive Behavior	.14	.52	.75	1.90
Siblings	Cooperation success	.00	1.37	.05	.84
Siblings	Interactive Behavior	.59	1.79	.00	1.42
Child care	Cooperation success	.57	7.97*	.43	8.25*
Child care	Interactive Behavior	.41	6.20	.34	.53
Gender	Cooperation success	2.53	5.78	3.99*	6.97 [†]
Gender	Interactive Behavior	5.63*	8.08*	.02	1.31

Note: Each affiliative model is compared with the affiliative model with only the path between affiliative behavior and cooperation success. Each antagonistic model is compared with the antagonistic model with only the path between antagonistic behavior and cooperation success fixed to zero and the mutual influence of the partner's antagonistic behaviors.

* $p < .05$, [†] $p < .10$.

across age as compared to the model with the path unequal across age, $\chi^2(2) = 3.68$, $p = .16$.

In step 4, we included all significant paths that resulted in a better model fit compared with the model fit with only a path from affiliative behavior to cooperation success, $\chi^2(6) = 36.40$, $p < .001$. The fit of this model was worse than the model in which the path from effortful control to cooperation success was included, $\chi^2(1) = 6.59$, $p = .01$. Adding the path from social competence to affiliative behavior did not result in a better model fit, $\chi^2(1) = .06$, $p = .80$. We removed social competence and siblings from the model as they did not contribute to better model fit. Furthermore, the model fit with paths equal for 2- and 3-year-olds was better than the previous model, $\chi^2(2) = .15$, $p = .93$. Thus, whereas the model for the 2- and 3-year-olds seemed to be the same, a different model was needed for the 4-year-olds. Moreover, model fit was better with the path from child care to cooperation success set to zero for 2- and 3-year-olds and the path from affiliative behavior to cooperation success set to zero for the 4-year-olds, $\chi^2(2) = 1.87$, $p = .39$.

At the end, the fit of this best fitting model was determined with a chi-squared difference test between the original fit of this model, $\chi^2(234) = 338.84$, $p < .001$, and the fit of the saturated model, $\chi^2(162) = 263.99$, $p < .001$, in which only means, variances, and covariances were estimated (see Kenny et al., 2006). The resulting chi-squared difference was $\chi^2(72) = 74.85$, $p = .39$, indicating adequate fit.

Associations with Antagonistic Behavior and Cooperation Success

The result of the multi-group modeling with antagonistic behavior was a model with only a mutual influence effect of antagonistic behavior, $\beta = .52$, $p = .004$, as antagonistic behavior was not related to other variables. The more antagonistic behavior one child of the dyad showed, the more antagonistic behaviors the other child showed. This model explained 33.1%, 0.6%, and 3.1% of the variance in antagonistic behavior for 2-, 3-, and 4-year-olds, respectively.

The model for antagonistic behavior was constructed following the same steps as the model for affiliative behavior. We began the analyses by testing first the path from antagonistic behavior to cooperation success, but the model without this path fit better than a model with this path equal or unequal across age, $\chi^2(1) = 3.69$, $p = .06$, and $\chi^2(3) = 4.75$, $p = .19$, respectively. As mentioned, there was an age-invariant mutual influence effect of antagonistic behavior, $\chi^2(1) = 11.44$, $p = .001$. Including paths from the predictors to antagonistic behavior did not yield better fit (Table 5). Therefore, all predictors were removed, resulting in a model with antagonistic behavior and cooperation success included. The chi-squared difference test between the original fit of this model ($\chi^2(13) = 15.82$, $p = .26$) and the fit of the saturated model ($\chi^2(9) = 10.99$, $p = .28$) resulted in adequate fit for this best fitting model, $\chi^2(4) = 4.83$, $p = .31$.

Discussion

In the current study, we investigated peer cooperation among young children of three age groups, examining both quality of interactive behavior and cooperation success. We examined how child characteristics and peer experiences were related to the development of interactive behavior and cooperation success during peer cooperation. Cooperation success showed a strong increase between 2 and 4 years of age. Whereas 2-year-olds coordinated their actions only infrequently, 3- and 4-year-olds were very proficient in cooperation. At first, these findings might seem at odds with Brownell

et al. (2006), who found indications of peer cooperation in 27-month-olds. However, in Brownell et al., both children had to pull a handle and thus perform a mutual imitative action, whereas our cooperation task required complementary or reciprocal actions, which might be more difficult (Eckerman & Peterman, 2004; Hunnius et al., 2009). Success on cooperation tasks that require complementary actions has indeed been found to develop only during the third year of life (Ashley & Tomasello, 1998; Brownell, 2011). It is important to consider how cognitive changes might explain differences in task success between the age groups. For example, being able to plan one's actions is an important prerequisite for cooperation (Gerson, Hunnius, & Bekkering, 2013; Obhi & Sebanz, 2011), an ability that develops throughout early childhood (Smyth & Mason, 1997; Zelazo, Carter, Reznick, & Frye, 1997). Moreover, being able to flexibly adapt your behavior in response to the cooperation partner's actions might play an important role (Brownell, 2011; Gerson et al., 2013).

With respect to the association between interactive behavior and cooperation success, we found that children who showed more affiliative behaviors were also more successful on the cooperation task. This is consistent with Ramani (2012) who found that better cooperation was related to more positive communication, such as making suggestions, describing the task goal, and agreeing to a peer's action. The lack of association between interactive behavior and cooperation success for the 4-year-olds might be due to a ceiling effect: the 4-year-old children tended to fail only on purpose or when they made the task more challenging, for example by playing very fast. A more difficult task might have been more appropriate to test the effect of interactive behavior on cooperation success, but would have resulted in higher dropout rates for the younger children.

No association was found between antagonistic behavior and cooperation success. This might be due to the function of antagonistic behavior in young children. On the one hand, antagonistic behavior, like aggression, can negatively affect social functioning (e.g., Hart, DeWolf, Wozniak, & Burts, 1992; NICHD Early Child Care Research Network, 2004). On the other hand, antagonistic behavior in young children serves a positive social function in peer interaction because it may be a normative part of early social exploration by which children discover how to best interact (Vaughn, Vollenweider, Bost, & Azria-Evans, 2003; Williams et al., 2007; Williams, Ontai, & Mastergeorge, 2010). This double function of antagonistic behavior might explain why we did not find simple positive or negative associations with cooperation success. For example, the antagonistic behavior 'claiming material' might have had a positive social function as by this behavior, children explored how they could encourage their peer to take turns and share toys.

The effect of child characteristics on interaction behavior was stable across age. The same child characteristics influenced affiliative behavior during peer cooperation among 2-, 3-, and 4-year-olds. As expected based on earlier research, girls at all ages showed more affiliative behavior than boys. This gender effect can be explained by boys' orientation to competition and dominance (Maccoby, 1990), which may have resulted in less affiliative behavior toward their dyad partner.

We also found that temperamental surgency was positively related to affiliative behavior, whereas negative affectivity was related negatively to affiliative behavior. Children who were more active and extroverted and less shy thus displayed more affiliative behavior. Our relation of surgency with affiliative behavior is not in accordance with Sterry et al. (2010) who found that in school-age children, more general activity (surgency) is related to less prosocial behavior. It is possible that surgency has

a different effect on peer interaction in younger children. Gunnar, Tout, de Haan, Pierce, and Stansbury (1997) indeed suggested a positive association between surgency and peer interaction in preschool children. They found that children with more surgency (and less negative affectivity) showed fewer negative behaviors, although an association with affiliative behaviors was not found. For negative affectivity, Laible, Carlo, Murphy, Augustine, and Roesch (2014) found that children's negative affectivity at 4 years of age was negatively associated with their prosocial behavior at 9 years. Our findings extend this knowledge by showing that younger children high in negative affectivity were also less affiliative with peers. There was no direct effect of gender, surgency, or negative affectivity on cooperation success. Therefore, the results suggest that both gender and temperament (surgency and negative affectivity) influence cooperation success via the quality of interactive behavior during the cooperation task.

There was also a direct effect of temperament on cooperation success. Children with better effortful control as reported by parents showed more cooperation success. This confirms recent results by Laible et al. (2014) who found a positive association between effortful control and parent-rated cooperative behavior among 4- to 9-year-olds. Although a direct association between effortful control and successful cooperation in younger children has not yet been reported, Kochanska and Knaack (2003) found that 22- to 45-month-old children with better effortful control were also better at internalizing rules at 56 months of age. Being able to internalize rules might be important in early peer cooperation given that children learn from adults that they have to share toys and take turns. As these behaviors were important in our cooperation task, this association between effortful control and internalizing rules could explain our positive association between effortful control and cooperation success.

For peer experiences, no association of siblings with cooperation or interactive behaviors was found. This could be explained by the heterogeneous nature of siblings (see Downey & Condrón, 2004), as children often had a sibling too young to fulfill a role as play partner. But cooperation was associated with the time 4-year-olds had spent in child care before entering preschool. This suggests that early peer experiences play an increasingly important role in young children's cooperation across development. A reason for this finding may be that mainly during the last period of child care before entering school, interactions with peers change to more cooperative play. This explanation is supported by Garnier and Latour (1994) who described that mainly between 40 and 50 months of age, children's play becomes more collaborative and interdependent. Moreover, Stolk, Hunnius, Bekkering, and Toni (2013) recently found that 5-year-old children who spent more time in child care before entering preschool were better in making communicative adjustments to a fictive 2-year-old child, which could also be relevant in cooperation with a less skilled peer. Children who attend child care possibly had more time to examine different ways of cooperating and to learn how to cooperate successfully with a peer. Further research is needed to clarify this association and see if this advantage for cooperation is only temporary.

No association was found between children's social competence and cooperation. This might be due to how social competence was assessed. We used the ITSEA, which asks parents to judge the social and emotional competence of their child. However, as parents observe their children mainly in family situations, this questionnaire may not be an ideal indicator of social competence in interactions with peers (Reddy, Hay, Murray, & Trevarthen, 1997).

The focus of this study on relevant proximal child and peer environmental predictors of cooperation does not rule out that other more distal predictors might also be relevant for cooperation development. For example, attachment is related to early social interaction (e.g., Hartup & van Lieshout, 1995). Securely attached children show increased willingness to be involved with others, and better social and emotional capacities (Sroufe, 2005). This might result in more and higher quality peer interactions, which, in turn, might also have a positive impact on cooperation success. However, it is still unclear whether a good mother–infant relationship is a prerequisite for or develops parallel to peer relationships (Hay et al., 2009). Moreover, attachment quality also seems to be influenced by temperament (Rothbart & Ahadi, 1994; van den Boom, 1994), which we assessed. Future studies could include both attachment and temperament and examine how they uniquely contribute to the development of cooperation.

In sum, this study adds to our knowledge of the development of peer cooperation in young children. The findings highlight how rapidly peer cooperation develops in young children and how both child characteristics and peer experiences play a role in it. Initially, children's temperament primarily influences cooperation, but as they grow older, previous peer experiences in child care come into play. A longitudinal study of peer cooperation development from early childhood to school age could provide further insight in the relative influence of child characteristics and peer experiences and their bidirectional influences across development.

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