Initial interactions matter: Warm-up play impacts 2-year-olds' cooperative ability with
an unfamiliar same-aged peer

Nichole Breeland^a, Annette M. E. Henderson^a, and Rachel Low^{a,b}

^a School of Psychology, The University of Auckland, New Zealand

^b Department of Psychology & Neuroscience, Auckland University of Technology, New
Zealand

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Corresponding authors: Nichole Breeland, nbre508@aucklanduni.ac.nz, Building 302 Level 2, 23 Symonds Street, Auckland, New Zealand 1010; Rachel Low rachel.low@aut.ac.nz; Annette M. E. Henderson a.henderson@auckland.ac.nz

Abstract

Interaction quality during cooperative exchanges impacts children's ability to successfully coordinate their actions with a same-aged peer to attain a shared goal. However, it is unclear how initial interactions in one context shape children's ability to cooperate in a subsequent task. In the present research, we examine whether the interaction quality (e.g., affiliation, antagonism, joint coordinated engagement, and joint contribution) of a warm-up period between two-year-old unfamiliar dyads ($N = 144$ dyads) predicts the dyad's performance and interaction quality in a following cooperative task. Children who participated more effectively during a toy clean-up activity at the end of the warm-up interaction were more likely to respond to their partner's efforts to cooperate in the novel cooperative task. Initial displays of affiliation during the warm-up period appeared to enhance cooperative ability by facilitating cooperative motivation. The present research demonstrates that initial interactions influence toddlers' cooperative performance and thus, highlights the importance of considering task order and children's social behaviors when designing studies on cooperative competence.

Keywords: Peer Cooperation, Toddlers, Interaction Quality, Context Spill-over, Prosocial Behavior

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Cooperative activities, where individuals coordinate their actions to attain shared goals, pervade most facets of human societies. Critically, research links children's ability to effectively coordinate their actions with social partners to their cognitive (Wu, Pan, Su, & Gros-Louis, 2013) and social (Plötner, Over, Carpenter, & Tomasello, 2015) functioning. Cooperation is also likely to indirectly influence individual well-being, with individuals who show increased social functioning (i.e., getting along and working well with others) demonstrating increased well-being (Endedijk, Cillessen, Bekkering, & Hunnius, 2020; Sette, Spinrad, & Baumgartner, 2013). The important role that cooperation plays across individuals and societies has motivated research aimed at understanding the developmental trajectory of cooperation (for reviews see Brownell, 2013; Warneken, 2017).

While much is known about the ages at which children can cooperate with others, little is known about the social elements and experiences that impact children's cooperative success. Identifying the social behaviors that support, or impede, cooperation is crucial for a comprehensive understanding of the factors that shape cooperative competence. We address this gap in the literature by testing how the social behaviors that two-year-old children display towards one another before and during a cooperative task, influence their ability to successfully coordinate their actions with one another to achieve a shared goal.

Cooperation and its Early Development

Before their first birthday, infants demonstrate elements of cooperative ability by engaging with their caregivers in social turn-taking games, such as peek-a-boo (Ross & Lollis, 1987). Fourteen-month-olds show the ability to attain a shared goal on novel cooperative tasks with an unfamiliar adult by reliably completing the same actions as their social partner, such as by holding a trampoline tight to bounce a toy (Warneken & Tomasello, 2007). Infants' cooperative ability continues to develop throughout the second year of their postnatal life as they become better able to attain shared goals in

novel tasks that require them to complete actions that are complementary to their adult social partner (Warneken, Chen, & Tomasello, 2006). Beyond the first two years of their lives, infants' cooperative ability continues to develop as they become more skilled at coordinating their actions with same-aged peers across a variety of tasks (for reviews see Brownell, 2013; Warneken, 2017). Together, these findings demonstrate that the physical ability to complete the required actions to cooperate with others shows marked development across the first three years of postnatal life.

Successful cooperation requires much more than the physical ability to carry out required actions. According to Bratman (1992), successful cooperation requires cooperative partners to be: 1) responsive to each other's intentions, 2) motivated to contribute mutually to the cooperative activity, and 3) committed to supporting each other's actions. Thus, while physical ability is critical to cooperative success, children's social understanding (e.g., understanding others' intentions so they may adjust their own physical behaviors) and behavior (e.g., willingness to coordinate one's actions with others) are also critical in shaping cooperative outcomes. To date, most research on the early development of cooperation has focussed on whether, or not, infants' actions resulted in successful goal attainment. This work has provided valuable information about *when* infants can cooperate, but has provided little information about *how* infants cooperate. Identifying the social elements that may support, or hinder, successful cooperation will provide insights into the processes underlying cooperation, which is critical in identifying ways to enhance cooperative developmental outcomes. The present research explores one candidate likely to affect cooperative success; how well cooperative partners function as a social unit.

Interaction Quality and Cooperation

Successful cooperation relies on cooperative partners to function as a cohesive social unit by closely attending to and being responsive to one another's intentions and actions (Bratman, 1992). In addition to completing the appropriate instrumental actions required to attain the goal, partners can support the interaction by engaging in supportive and motivational affiliative behaviors such as positive directing and helping

(Endedijk, Cillessen, Cox, Bekkering, & Hunnius, 2015; Hunnius, Bekkering, & Cillessen, 2009). For example, a child who demonstrates affiliation towards another child by helping them perform their role on a task not only supports their partners actions but also conveys their commitment to attaining the shared goal together. In contrast, cooperative success is unlikely to occur when cooperative partners engage in antagonistic behaviors such as criticizing their partner or behaving competitively. In sum, the ways that social partners contribute to the quality of the interaction can either facilitate cooperation by conveying cooperative intentions, or undermine them by conveying individualistic or competitive intentions.

Previous research has demonstrated the effects of affiliation and antagonism on children's social interactions by examining children's free-play and naturalistic joint activities. In general, the evidence suggests that displays of affiliation and low levels of antagonism facilitate peer relationships by increasing peer acceptance thereby enabling the attainment of social goals, such as making friends or engaging in coordinated gameplay (e.g., hide-and-go-seek, Sette et al., 2013; Vaughn et al., 2009). To date, one study has examined how the quality of the interaction affects peer cooperation within an experimental setting. Endedijk et al. (2015) observed two- to four-year-olds' affiliation (e.g., smiling or helping) and antagonism (e.g., aggression) during a cooperative task with a same-aged peer. The results revealed that two- and three-year-old dyads who demonstrated higher levels of affiliation were more likely to show cooperative success (i.e., the number of times the dyad achieved the shared goal of sliding a toy through an angled tube). This effect was not present for four-year-old dyads, which the researchers argued was likely due to ceiling effects on the cooperative task. Alternatively, these findings may suggest that social behaviors are particularly important in shaping cooperative success between young children with limited verbal abilities (i.e., children who may have difficulty in verbally conveying their intentions and interpreting their partner's intentions). Regardless, these findings demonstrate that cooperative partners' affiliation towards one another is an important index of how the social unit is functioning and affects young children's ability to attain shared goals

within a cooperative context.

Affiliation may support cooperative exchanges by supporting the coordination of actions within the interaction itself. However, it is also possible that interaction quality can impact cooperative success by enhancing an individual's motivation to cooperate with their social partner through rapport building. This is likely to be important when individuals cooperate with an unfamiliar social partner. Support for this possibility comes from experimental studies showing how prior experience with a social partner influences young children's subsequent interactions with the same individual. For example, 16-month-olds and one- to two-year-olds who engaged in warm-up play or friendly, synchronous exchanges with an unfamiliar adult experimenter, respectively, were more likely to respond to the adult's bids for help in a subsequent task (Barragan & Dweck, 2014; Schuhmacher, Köster, & Kärtner, 2019). Infants who coordinated their behaviors in a stack-and-topple task (i.e., cooperative block stacking) with an adult, or engaged in joint rhythmic movement (i.e., swinging in a synchronous manner on a swing set) with a peer, were more likely to engage in instrumental helping and coordinate button presses with their social partner to achieve a goal on subsequent tasks (Barragan & Dweck, 2014; Rabinowitch & Meltzoff, 2017a, 2017b). Thus, while the findings reported by Endedijk et al. (2015) suggest that the quality of an ongoing social interaction is a keystone in supporting cooperative outcomes, the research described above supports the possibility that social and coordination processes are likely to shape cooperative interactions well before the task begins; a point that requires more attention.

The lack of research on the role that initial interactions play in children's cooperation is surprising given that many studies that investigate cooperation between peers report a warm-up period in which children become familiarized to one another before engaging in a cooperative task (Brownell, Ramani, & Zerwas, 2006; Endedijk et al., 2015; Hepach, Kante, & Tomasello, 2017). Warm-up periods are designed to allow the children to interact with one another and a variety of child-friendly toys in an unstructured manner. Arguably, a key goal of warm-up play is to build rapport between

the social partners. As such, investigating the extent to which the interaction quality of a warm-up interaction affects the interaction quality and outcomes of a subsequent cooperative interaction are important and open research questions.

Schuhmacher and Kärtner (2015) partially examined these questions by examining the effects of the quality of an initial interaction between unfamiliar 36-month-old dyads on their future cooperative ability and motivation. Schuhmacher and Kärtner (2015) found that dyads who experienced a greater number of positive-harmonious interactions (versus hostile-aggressive interactions) in an introductory free-play period showed an increased preference to engage in joint play, rather than individual play, in a later partner choice task. However, in contrast to findings by Endedijk et al. (2015), more positive interactions were not associated with enhanced cooperative ability. Schuhmacher and Kärtner's findings suggest that positive and harmonious initial interactions between unfamiliar 36-month-old dyads enhance children's motivation to play jointly, rather than individually, when presented with a choice. These findings provide initial evidence suggesting that the quality of warm-up interactions between unfamiliar dyads is important to consider, as it may impact subsequent interactions. However, several questions regarding how initial interactions shape subsequent cooperative interactions remain unanswered.

First, the extent to which the quality of the warm-up interaction impacts the dyad's subsequent interaction quality and cooperative ability remains unclear. Apart from offering valuable insight into these effects and how social interactions may be used to support cooperative exchanges, examining these associations will inform future studies by shedding light on potential confounding factors, such as the task order of an experimental study, that may impact children's cooperative abilities. Second, since Schuhmacher and Kärtner (2015) assigned each member of the dyad the same score, it remains unclear how the behavior of each dyad member contributes to the interaction quality and success during cooperation. By utilizing approaches that enable us to control for the interdependence of the dyad, the present research offers an enhanced understanding of the dyadic nature of social interaction. Thirdly, because Schuhmacher

and Kärtner (2015) did not test if initial interaction quality (i.e., occurring within the first few minutes of the warm-up task, before the children have established rapport) or later interaction quality (i.e., occurring within the last few minutes of the warm-up task, when it is assumed the children have established rapport) exerts divergent effects on subsequent cooperative ability and interaction quality, it is unknown if initial interactions truly matter. Lastly, it remains unknown whether, or not, initial interactions facilitate cooperative exchanges between younger children who are just approaching their second birthday. Interaction quality may be more critical for toddlers who's cooperative abilities with a peer and language abilities are less developed than older children and thus, may be more reliant on emotive behaviors to support their cooperative endeavors.

The Present Study

The present research builds on previous work and addresses the questions raised above by examining if the interaction quality between two unfamiliar (i.e., met during the experimental session for the first time) two-year-old children: 1) during a cooperative task predicts their performance on the task, 2) during a warm-up period prior to the cooperative task relates to their performance on the subsequent cooperative task, and 3) during the warm-up period relates to the quality of their interaction during the cooperative task. We assessed the following indicators of interaction quality: affiliation (i.e., behaviors that facilitate interactions such as sharing or smiling; see also Endedijk et al., 2015; Hunnius et al., 2009), antagonism (i.e., behaviors that hinder interactions such as aggression or competing; see also Endedijk et al., 2015; Hunnius et al., 2009), and joint coordinated engagement (JCE; i.e., how well the child coordinates their attention, or actions and attention, with the other child's actions or attention; adapted from Adamson, Bakeman, Deckner, & Nelson, 2012; Bakeman & Adamson, 1984). To examine whether cooperative behavior on an unrelated shared-goal activity impacts cooperative task performance, we assessed the extent to which each child helped clean-up the warm-up toys when prompted at the end of the warm-up phase.

The post warm-up phase cooperative task required both children to hold down a respective handle to activate a spinning, light-up robot (adapted from Brownell et al., 2006). We assessed cooperative ability in three ways: success (i.e., the dyad activated the robot), initiating behavior (i.e., when the robot was activated, which child held the handle down first), and responding behavior (i.e., when the robot was activated, which child held their handle down second). We included initiating and responding behaviors as measures of cooperative ability to account for the different dynamics within a cooperative exchange that contribute to shared-goal attainment. Cooperative motivation was thought to underlie initiating behavior and spatial coordination was thought to underlie responding behavior.

Consistent with the findings reported by Endediijk et al. (2015), we expected that affiliation, but not antagonism, during both the warm-up and cooperative task would predict enhanced cooperative ability on all three measures. Consistent with research by Bakeman and Adamson (1984), Barragan and Dweck (2014), and Rabinowitch and Meltzoff (2017a, 2017b), we hypothesized that increased JCE (during either the warm-up or the cooperative task) or increased contribution to the toy clean-up (during the warm-up) would predict children's enhanced cooperative ability.

To our knowledge, no research has examined how the interaction quality between two unfamiliar two-year-old children influences the quality of a later interaction. However, similar research regarding spill-over effects suggests that human behaviors in one context are linked to and thus, impact behaviors in successive contexts (Dolan & Galizzi, 2015). Concordantly, we expected that the interaction quality between dyads would be consistent across tasks. Additionally, we believed it was reasonable to expect that increased warm-up antagonism would be associated with reduced cooperative task affiliation, and vice-versa. Thus, we conducted exploratory analyses to offer the first examination of how different indicators of social interaction quality influence each other within and across contexts. Initial interactions shape how we interact with other individuals in social exchanges. This study extends the literature on early cooperative behavior by providing a comprehensive examination of how the quality of an interaction

shapes cooperative outcomes, even before the cooperative exchange begins.

Method

Participants

We utilized data collected from 144 same-sex, two-year-old dyads (male dyads = 72). One dyad member was participating in an ongoing longitudinal study investigating prosocial behavior development across early childhood. Data was collected during the fourth data collection wave (DCW4) of the study. We recruited the other dyad member specifically for DCW4. Researchers recruited participants from a database of families who lived within a New Zealand and expressed an interest in participating in child development research at the University of Auckland. Parents received an invitation for their child to participate in the study if their child was exposed to English at least 70% of waking hours, born after 37 weeks gestational age, and had not received a developmental-related diagnosis. Before each session, researchers paired one-off “peer” participants with a longitudinal participant of the same age (± 3 months) to form the dyad. Table 1 contains demographic information (e.g., children’s age, ethnicity, and caregiver’s SES). Researchers entered the caregivers name into a draw to win a \$50 voucher and each child received a small toy for their participation.

Materials and Procedure

Separate experimenters conducted consent procedures for each family to ensure that the children did not meet prior to the warm-up introduction. The longitudinal participant completed a battery of tasks as part of the broader study before interacting with the peer participant. Only the tasks relevant to this study are described. A second experimenter (E2) led the peer and their caregiver into a room to meet the longitudinal participant, their caregiver, and the other experimenter (E1). The room contained several toys and ceiling-mounted cameras which recorded the session for offline coding. See the Online Supplementary Materials (OSM) for additional procedural details.

Warm-Up Play. E1 initiated the warm-up phase by introducing the children to each other and stating that they could play with the toys (see Figure 1). The warm-up lasted for eight minutes during which E1, E2, and the children interacted with each

Table 1
Demographic Information

	<i>Mean(SD)</i>	Range	Percent of Sample
Age (months)	22.7(1.87)	17.30 - 31.53	
Infant Ethnicity (Maternal Report)			
Pacific			.35%
Maori-OE			.35%
MELLAA-OE			.35%
Asian			.69%
Other			.69%
Non-New Zealand European (OE)			.69%
NZE-Pacific			1.39%
NZE-Maori			5.21%
NZE-Asian			5.56%
Unknown			7.29%
Two or more			10.07%
New Zealand European (NZE)			67.36%
Mother's Highest Tertiary Qualification			
Unknown			2.77%
Other tertiary qualification			16.32%
Graduate degree			17.36%
Bachelor degree or diploma			29.17%
High school diploma			34.38%

Note. MELAA = Middle Eastern, Latin American or African. Mothers' self-reported highest tertiary qualification level is used as a the metric for SES.

other in a naturalistic manner, with E1 and E2 ensuring that they did not initiate any structured cooperative activities. After eight-minutes, E1 said "let's clean up these toys, and I will show you a new game."

Cooperative Task. We adapted the cooperative task procedure and apparatus (see Figure 1) from Brownell et al. (2006). E1 instructed caregivers to sit away from the cooperative task and to avoid providing the dyad with task-specific help. E1 introduced the task goal and the actions required for goal attainment (see Figure 1).

E1 invited the dyad to play with the apparatus for three minutes. If successful, E1 provided non-directive encouragement throughout. If the dyad failed to activate the robot after: 1) one minute, then E1 provided directive prompts, 2) two minutes, then E1 and E2 repeated a demonstration three times, 3) the second demonstration, then E1

Figure 1. Warm-up play and peer cooperative tasks. Left panel: warm-up play. Centre panel: toy clean-up phase at the end of the warm-up interaction. Right panel: cooperative task that required the dyad to coordinate their actions by pushing and holding two opposing handles down at the same time in order to achieve the shared goal of activating the lights and motion on a toy robot. From auckland.figshare.com. Copyright Breeland and Henderson (2021).

provided directive prompts until the task's end.

Interaction Quality Coding

We assessed the interaction quality of the warm-up and cooperative task by coding three types of behavior: affiliation, antagonism, and JCE. We also coded each child's contribution to the toy clean-up phase at the end of the warm-up. See Table 2 for definitions and reliability.

We split the warm-up interaction into two 90-second blocks for coding. Block 1 (B1; first 90-seconds) captured interaction quality before children established rapport and Block 2 (B2; last 90-seconds) captured interaction quality after children established rapport. Both blocks were split into 30-second sets using INTERACT (Mangold, 2020) for coding. We also split and coded the cooperative task in 30-second sets, which aligned with the warm-up play coding and the timing of E1's task prompts.

Table 2

Warm-up and Cooperative Task Coding Constructs, Definitions, and Associated Inter-rater Reliability

Construct	Definition	Scoring
<i>Interaction Quality</i>		
Affiliation	Behaviors or verbalisations that facilitate the social interaction (e.g., smiling, helping, directing with a positive tone, encouragement, or moving next to peer).	0 = No affiliation 1 = Affiliation (ICCs = .86 - .97)
Antagonism	Behaviors or verbalisations that hinder the social interaction (e.g., competing, directing with a negative tone, hitting, crying, or neglecting their peer).	0 = No antagonism 1 = Antagonism (ICCs = .89 - .99)
JCE	Broad index of how well each child coordinated their attention and behavior with the other child.	1 = No coordination 2 = Passive 3 = Rare coordinated 4 = Inconsistent coordinated 5 = Active coordinated (ICCs = .89 - .96)
Contribution	Index of how well each child contributed to a semi-structured shared-goal toy clean-up activity before the cooperative task. A contribution was defined as putting a toy away into a box. A child who received a score reflective of compliance contributed only after being prompted a second time whereas a child who received a score reflective of cooperation contributed without requiring a second prompt.	1 = No effort 2 = Reluctant compliance 3 = Enthusiastic compliance 4 = Inconsistent cooperation 5 = Extremely cooperative (ICC = .94)

Table 2

Warm-up and Cooperative Task Coding Constructs, Definitions, and Associated Inter-rater Reliability

Construct	Definition	Scoring
<i>Cooperative Ability</i>		
Initiating	Behaviors that highlight the cooperative motivation aspect of cooperative ability in that they demonstrate a bid for coordination (i.e., a child who pushes their handle down first in a cooperative action sequence would be initiating).	0 = No initiating 1 = Initiating
Responding	Behaviors that highlight the coordination aspect of cooperative ability in that they require the actor to observe, understand, and react to their partner's behavior (i.e., a child who pushes their handle down after their social partner pushes their handle down in a cooperative action sequence would be responding).	0 = No responding 1 = Responding
Success	A binary measure indicating whether or not the dyad attained the shared-goal of activating the spinning and light-up features on a toy robot at least once by holding down a pair of opposing handles simultaneously.	0 = No success 1 = Success

Note. JCE = Joint Coordinated Engagement. Coders originally rated affiliation and antagonism on a 7-point Likert scale (1 = *child never displayed target behavior*, 7 = *child displayed target behavior almost all of the time*). We later converted affiliation and antagonism to a binary measure due to restricted range (see OSM Table 1). We originally calculated the frequency of initiating, and responding via contingency analysis in INTERACT (Mangold, 2020) using the coding of each child's handle presses (described in Coding Section). We later converted initiating and responding to a binary measure due to a restricted range (see OSM Table 1). We included a binary measure of success in lieu of a latency or success frequency score (see Brownell & Carriger, 1990; Endedijk et al., 2015) given that fewer than 50% of dyads attained the goal. Consistent with parameters determined by Brownell et al. (2006), to qualify as a successful cooperative action sequence, initiating and responding had to occur within $\pm$ three seconds. Reliability statistics for cooperative ability measures are noted within the text. We adapted coding for: Affiliation and Antagonism from Endedijk et al. (2015) and Hunnius et al. (2009) and JCE from Adamson et al. (2012) and Bakeman and Adamson (1984). Children's affiliation, antagonism, or JCE towards the apparatus, caregivers, or experimenters was not coded.

Research assistants completed all of the cooperative task coding before coding the warm-up interaction. Pairs of coders viewed each interaction together, but independently rated the interaction quality for each dyad member. The coders remained blind to the participating status (i.e., longitudinal or one-off) of the child and viewed each 30-second set a minimum of two times with the option of additional viewings if required. The coders discussed their independent ratings after coding all of the constructs within all of the sets. The child's final score was either: the coders' identical scores (when they agreed either before or after their discussion) or the coders' averaged scores (if disagreements held after discussion). We conducted reliability analyses on the coders' independent scores (see Table 2). Each dyad member received an average score for each warm-up measure for B1 and B2¹ and for each cooperative task interaction quality measure; however, due to a restricted range, we re-coded affiliation and antagonism as a binary score (see OSM Table 1 and Table 2).

Cooperative Ability Coding

We utilized children's handle press onset and offset duration behaviors to create three measures of cooperative ability: initiating, responding, and success. Each child received scores which reflected their cooperative ability as described in Table 2. A research assistant and the lead author of this manuscript coded the instances where children held a handle all the way down on the apparatus frame-by-frame at 25 frames per second using INTERACT (Mangold, 2020). We conducted reliability analyses on 30% of the sample. Agreement was met if coders indicated that the onset or offset occurred within a ± 160 milliseconds. Coders obtained excellent percent agreement (onset = 84.3% offset = 82.5%). Kappas for coders' judgments regarding which child completed the action ($\kappa = .79$) upon which handle ($\kappa = .77$) was strong (Hallgren, 2012).

Results and Discussion

We conducted all analyses using R software (R Core Team, 2020). We assessed significance at $p < .05$. Supplementary materials for all statistical tests can be found at

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¹ With the exception of contribution, which occurred during B2 only.

<https://osf.io/75m6p/>.

Preliminary Analyses

Outliers ($\pm 3 SD$ from the mean) emerged for all JCE measures. We did not exclude or replace outliers as they represent valid observations, and analyses with a windsorized dataset revealed the same pattern of results. Neither the contribution nor JCE measures satisfied normality requirements. Analyses including these variables utilized non-parametric tests or data transformations.

We included gender in the relevant analyses as a control because preliminary analyses revealed that males were more likely than females to engage in initiating and responding during the cooperative task, $X^2(1, N = 270) = 4, p = .04$, for both measures. We did not include age as a control given it was not significantly associated with any outcome measures.

Table 3
Descriptive Statistics and Correlations Across Primary Measures

Measures	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Warm-Up Interaction Quality													
1. Affiliation B1													
2. Affiliation B2	.17_φ*												
3. Antagonism B1	.02 _φ	.05 _φ											
4. Antagonism B2	-.02 _φ	.02 _φ	.04 _φ										
5. JCE B1	.39_{pb}**	.17_{pb}*	.39_{pb}**	-.06 _{pb}									
6. JCE B2	.17_{pb}*	.39_{pb}**	.08 _{pb}	.22_{pb}**	.27_r**								
7. Contribution	.01 _{pb}	.15_{pb}*	.04 _{pb}	.05 _{pb}	.04 _r	.26_r**							
Cooperative Task Interaction Quality													
8. Affiliation	.15_φ*	.04 _φ	.14_φ*	.06 _φ	.15_{pb}*	.05 _{pb}	.18_{pb}**						
9. Antagonism	.03 _φ	-.01 _φ	.20_φ**	.02 _φ	.13 _{pb}	.07 _{pb}	-.01 _{pb}	.21_φ**					
10. JCE	.13 _{pb}	-.02 _{pb}	.19_{pb}**	.00 _{pb}	.18_r*	.12 _r	.10 _r	.36_{pb}**	.21_{pb}**				
Cooperative Task Ability													
11. Initiating	.10 _φ	.08 _φ	.16_φ*	.06 _φ	.18_{pb}**	.06 _{pb}	.11 _{pb}	.22_φ**	.07 _φ	.44_{pb}**			
12. Responding	.03 _φ	.08 _φ	.20_φ**	.06 _φ	.17_{pb}*	.06 _{pb}	.16_{pb}*	.20_φ**	.05 _φ	.45_{pb}**	.81_φ**		
13. Success	.09 _φ	.10 _φ	.16_φ*	.07 _φ	.19_{pb}**	.08 _{pb}	.16_{pb}*	.24_φ**	.09 _φ	.44_{pb}**	.91_φ**	.91_φ**	
Possible Range	0 1	0 1	0 1	0 1	1 – 5	1 – 5	1 – 5	0 1	0 1	1 – 5	0 1	0 1	0 1
Actual Range	0 1	0 1	0 1	0 1	1 – 3.33	1 – 4	1 – 5	0 1	0 1	1 – 4.17	0 1	0 1	0 1
Mean	-	-	-	-	1.66	1.83	2.57	-	-	1.48	-	-	-
SD	-	-	-	-	.48	.64	1.26	-	-	.54	-	-	-
Frequency	1 = 60 0 = 159	1 = 51 0 = 171	1 = 20 0 = 199	1 = 45 0 = 177	n = 219	n = 222	n = 222	1 = 65 0 = 205	1 = 52 0 = 218	n = 270	1 = 72 0 = 198	1 = 72 0 = 198	1 = 82 0 = 188

Note. JCE = Joint Coordinated Engagement. B1 = Block 1. B2 = Block 2. _r indicates Pearson coefficient. _{pb} indicates Point-biserial coefficient. _φ indicates Phi coefficient. *n* indicates the number of data points per variable. * indicates $p < .05$. ** indicates $p < .01$. Significant effects are featured in **bold**.

Focal Analyses

We employed statistical techniques that allowed us to include a random effect of dyad number to treat children as individual participants while controlling for dyadic non-independence (Kenny, Kashy, & Cook, 2006) within the analyses. We used Linear Mixed Models (LMM) via the R package "lme4" (Bates, Maechler, Bolker, & Steve, 2015) for models which predicted JCE. We employed Generalized Estimating Equations (GEE) via the R package "geepack" (Højsgaard, Halekoh, & Yan, 2006) for models which predicted the binary variables. Estimates, standard errors, and Wald statistics for all models can be found in Table 4 and 5.

Table 4
Results from Generalized Estimating Equations and Linear Mixed Models Testing the Effects of Cooperative Task Interaction Quality on Cooperative Task Ability and Interaction Quality

Predictors	Cooperative Task Ability						Cooperative Task Interaction Quality					
	Initiating		Responding		Success		Affiliation		Antagonism		JCE $\sqrt[3]{v}$	
	Estimate	X^2	Estimate	X^2	Estimate	X^2	Estimate	X^2	Estimate	X^2	Estimate	t
<i>Models Assessing Effects of Cooperative Task Interaction Quality on Cooperative Task Ability and Interaction Quality</i>												
Affiliation	.25(.25)	1	-.03(.27)	.01	-.01(.02)	.18	-	-	.78(.35)	5.09*	.08(.01)	5.40***
Antagonism	.17(.24)	.54	-.05(.29)	.03	.03(.02)	2.14	.65(.35)	3.39	-	-	.02(.01)	1.04
JCE	.84(.26)	10.71**	1.14(.28)	16.07***	-.18(.05)	10.25**	1.54(.39)	15.70***	.57(.28)	4.03*	-	-
Gender	-.56(.36)	2.34	-.58(.36)	.11								

Note. JCE = Joint Coordinated Engagement. Estimated parameters (with standard errors in parentheses) are presented. Standard errors reflect sandwich estimator values. X^2 indicates Wald statistic. $\sqrt[3]{v}$ indicates cube root transformation of variable. * indicates $p < .05$. ** indicates $p < .01$. *** indicates $p < .001$. Statistically significant estimates are featured in **bold**. Effects in *italics* represent exploratory analyses.

Table 5

Results from Generalized Estimating Equations and Linear Mixed Models Testing the Effects of Warm-Up Interaction Quality on Cooperative Task Ability and Interaction Quality

Predictors	Cooperative Task Ability						Cooperative Task Interaction Quality					
	Initiating		Responding		Success		Affiliation		Antagonism		JCE $\sqrt[3]{v}$	
	Estimate	X^2	Estimate	X^2	Estimate	X^2	Estimate	X^2	Estimate	X^2	Estimate	t
<i>Models Assessing Effects of Warm-Up Interaction Quality During B1 on Cooperative Task Ability and Interaction Quality</i>												
Affiliation B1	.62(.28)	4.88*	-.35(.31)	.71	-.01(.01)	1.74	.40(.41)	.95	.27(.46)	.35	.02(.02)	1.20
Antagonism B1	.04(.43)	.01	.65(.43)	2.25	-.03(.02)	1.74	.76(.47)	2.62	1.30(.72)	3.28	.01(.03)	.23
JCE B1	.24(.16)	2.11	.21(.16)	1.84	-.02(.01)	3.37	.36(.37)	.94	-.06(.62)	.01	.01(.02)	.74
Gender	-.66(.43)	2.33	-.48 (.42)	1.27								
<i>Models Assessing Effects of Warm-Up Interaction Quality During B2 on Cooperative Task Ability and Interaction Quality</i>												
Affiliation B2	.11(.32)	.13	.03(.30)	.01	-.004(.01)	.63	.09(.39)	.05	-.29(.48)	.36	-.02(.02)	-.96
Antagonism B2	.12(.32)	.14	.07(.33)	.04	-.01(.01)	.78	.28(.40)	.50	.09(.50)	.03	-.003(.02)	-.19
JCE B2	.06(.22)	.08	.12(.23)	.26	-.01(.01)	1.10	-.19(.30)	.41	.22(.34)	.40	.02(.01)	1.24
Contribution	-.04(.07)	.37	.15(.06)	5.44*	-.003(.002)	4.16*	.35(.12)	8.04**	.04(.14)	.07	.01(.01)	1.89
Gender	-.52(.42)	1.48	.55(.42)	1.74								

Note. JCE = Joint Coordinated Engagement. B1 = Block 1. B2 = Block 2. Estimated parameters (with standard errors in parentheses) are presented. Standard errors reflect sandwich estimator values. X^2 indicates Wald statistic. $\sqrt[3]{v}$ indicates cube root transformation of variable. * indicates $p < .05$. ** indicates $p < .01$. *** indicates $p < .001$. Statistically significant estimates are featured in **bold**.

Cooperative Task Interaction Quality and Ability. Consistent with previous work demonstrating that affiliation is associated with cooperative success (Endedijk et al., 2015), we expected that increased affiliation during the cooperative task would predict enhanced cooperative ability. GEEs with affiliation, antagonism, and JCE as predictors for each cooperative ability measure revealed that neither cooperative task affiliation nor antagonism were associated with cooperative ability. This unexpected inconsistency between the present study and previous research by Endedijk et al. (2015) may have resulted from key differences between the studies. First, our analysis inclusion criteria differed substantially from Endedijk and colleagues. Endedijk et al. (2015) conducted analyses on dyads who achieved the shared goal within the task at least five times, whereas we did not exclude dyads from our analyses based on shared-goal attainment (i.e., we analyzed data for both successful and unsuccessful dyads). This served to: 1) maintain sample size and 2) provide a comprehensive investigation of how quality and ability predict one another regardless of success. It is possible that analyses including only the "successful" dyads may reveal different findings, however this would involve excluding over half of our sample, under power the analyses, and limit the generalisability of our findings.

Endedijk et al. (2015) utilized a task that required one child to place an object into the top of a slide-like dual-tube system while the other child caught the object at the bottom of the appropriate tube. In contrast, children in the present study were required to hold two opposing handles completely down simultaneously to activate a toy robot. We did not anticipate that the dyads in the present study would find the task difficult; however, the fact that 56% of the dyads failed to attain the shared goal at least once suggests the contrary. The low success rate we observed could be due to the age of our sample. The age range in our study was 17 to 31 months ($M_{age} = 23$ months), whereas Endedijk and colleagues observed 28- to 55-month-old dyads. Perhaps in the earlier stages of cooperative development, the interaction quality between same-aged peers is not as critical to shaping cooperative outcomes as other aspects of cooperative competence, such as individual social cognition or basic communicative abilities. Future

research could examine other aspects of children's cooperative competence and their effects on cooperative performance during tasks of varying difficulty.

Based on research by Barragan and Dweck (2014) and Rabinowitch and Meltzoff (2017b) which suggests that coordinated processes facilitate cooperative exchanges, we expected that increased JCE would predict enhanced cooperative ability. Our study showed that a one-unit increase in cooperative task JCE significantly predicted a: 16% decrease in the likelihood of success, 132% increase in the likelihood of initiating, and a 213% increase in the likelihood of responding.

Broadly, our results suggest that children who were more likely to coordinate their attention and actions with an unfamiliar peer during the cooperative exchange were more likely to fulfill the roles needed to attain the shared goal. One potential explanation for this association is that JCE, responding, and initiating likely rely on the development of a common underlying mechanism; the ability to anticipate others' actions and coordinate one's actions with others. Initiating is most useful if it occurs when one's cooperative partner is able to display responding. This is consistent with findings by Brownell et al. (2006) who showed that 23-month-olds engage in cooperative actions when their social partners have the ability to respond, as opposed to when they do not.

Unexpectedly, children who engaged in increased cooperative task JCE were less likely to be successful. JCE is arguably a more lenient measure of coordination because it captures behaviors that are coordinated, but do not achieve the goal. The 56% of the sample that remained unsuccessful likely coordinated their attention and actions and may have almost achieved the goal, but failed to hold the handles on the apparatus down all the way. Indeed, previous research suggests that cooperative ability between same-aged peers emerges around the age of 24 months, but is not considered reliable until around 36 months (for a review see Warneken, 2017). Examining "near misses" in future work may provide further insight into the relationship between JCE and cooperative success.

In sum, we observed mixed support for our hypotheses. Affiliation did not predict

cooperative ability. Although this is at odds with Endedijk et al. (2015), our results are likely due to our inclusive analysis procedure or due to the dyads finding the task difficult. Support for our hypotheses emerged primarily in relation to the JCE measure. Increased JCE predicted children's increased initiating and responding, but not success. These findings highlight the importance of considering individual-based cooperative ability metrics when aiming to gain insights on children's cooperative performance. Taken together, our findings call into question the generalisability of previous research which suggests that children's increased affiliation is associated with increased cooperative success. Additionally, our findings point to limitations in failing to recognize the individual behavioral contributions that facilitate shared-goal attainment within dyadic cooperative exchanges. Future research could consider task difficulty, analysis inclusion criteria, and individual roles within a cooperative change to best explain children's early cooperative development.

Warm-up Interaction Quality and Cooperative Task Interaction

Quality. Based on evidence which suggests that both positive and negative behaviors demonstrate spill-over effects across several life domains (Dilworth, 2004; Dolan & Galizzi, 2015; McAuliffe, Burton-Chellew, & McCullough, 2019), we predicted that the quality of a warm-up interaction between two unfamiliar two-year-old children would spill-over on the subsequent cooperative interaction by being associated with similar or same social behaviors during the cooperative task. To test the effects of warm-up interaction quality on children's cooperative task affiliation and antagonism, we conducted four separate GEE analyses where either warm-up B1 or B2 interaction quality predicted cooperative task affiliation or antagonism. Results indicated that increased contribution during warm-up B2 was associated with a 42% increase in the likelihood of displaying cooperative task affiliation; suggesting that increased participation in a familiar joint task of cleaning up toys at the end of the warm-up spills-over to encourage supportive social behaviors in a subsequent cooperative interaction with the same social partner. No additional significant results emerged.

Our finding that children who were more likely to fulfill their social obligation and

contribute to putting away the toys during the warm-up were more likely to show increased affiliation during the following cooperative task provides evidence in support of spill-over effects within cooperative contexts. This finding builds on prior research demonstrating that coordinated movement impacts cooperative outcomes (Barragan & Dweck, 2014; Rabinowitch & Meltzoff, 2017b) by offering a potential mechanism for this explanation. Our results suggest that increased participation in a joint coordinated activity may assist in rapport building and thus facilitate the later display of social behaviors that support cooperation. Although future research is needed to examine these links, these findings have important implications for cooperative development. Perhaps designing interventions consisting of a joint action component could enhance cooperative outcomes in a variety of contexts by supporting rapport-building and promoting the display of positive social behaviors.

One interpretation for the lack of statistically significant results regarding warm-up affiliation and antagonism as predictors of cooperative interaction quality is that that children may have utilized these behaviors to convey task-specific intentions. Endedijk et al. (2015) and Hunnius et al. (2009) have proposed that affiliation and antagonism convey intentionality concerning an object, or a shared goal. Thus, given that the goals across the tasks differed (i.e., free-play versus activating a toy robot), it is plausible that affiliation and antagonism served differing, goal-specific functions and may exist as context specific social behaviors, particularly when peers are unfamiliar with one another. However, more research is needed to support this claim.

To test the effects of warm-up interaction quality on cooperative task JCE, we generated a LMM with the either warm-up B1 or B2 interaction quality as the predictors of cube root transformed cooperative task JCE; however, no significant associations emerged. Our finding that warm-up JCE was not associated with increased cooperative task JCE is inconsistent with research that suggests that engaging in joint synchronous movement before a cooperative task increases coordinated behavior in a subsequent cooperative task (Rabinowitch & Meltzoff, 2017b). It is likely that this inconsistency is due to floor and task effects; the average scores for JCE were under two

with a restricted range which suggests that children did not actively coordinate their attention *and* actions with their social partner. Floor effects may be due to the unstructured nature of the warm-up task which meant that dyads were not required to engage in joint coordinated action for any amount of time (i.e., dyads engaged in both parallel and reciprocal play). This is inconsistent with findings by Barragan and Dweck (2014) and Rabinowitch and Meltzoff (2017b), who intentionally had participants actively engage in a joint coordinated activity (i.e., swinging synchronously on a swing set) prior to a cooperative task. Overall, our results suggest that simply attending to one's social partner before cooperating is not enough to elicit JCE in a future cooperative task. More research is needed to determine if higher levels of JCE elicit similar responses within a cooperative task.

Warm-up Interaction Quality and Cooperative Ability. Based on research by Schuhmacher and Kärtner (2015) and Barragan and Dweck (2014) that showed positive interaction quality and joint coordinated movement predicts future cooperative outcomes, we predicted that children who exhibited affiliation or increased JCE during either block of the warm-up, or were more likely to contribute to toy clean-up during warm-up B2, would show enhanced cooperative ability. We conducted separate GEE tests with either warm-up B1 or B2 interaction quality as predictors of each cooperative ability measure. Results revealed that displays of warm-up B1 affiliation, but not B2, predicted an 86% increase in the likelihood of initiating. Additionally, for every one-unit increase in contribution, the likelihood of responding increased by 16%; however, the likelihood of cooperative task success decreased by 0.3%. No additional significant results emerged.

Generally, our results support the notion that the warm-up interaction quality impacts subsequent cooperative behavior. Our findings indicate that interaction quality may spill-over across contexts, but rather than re-manifesting as interaction quality, spill-over is observed as cooperative ability. Displays of affiliation during the first 90-seconds of the warm-up were associated with an increased likelihood of engaging in initiating, but not responding or success, during the cooperative task. These findings

are consistent with findings reported by Schuhmacher and Kärtner (2015) who demonstrated that three-year-olds who had positive initial social experiences were more likely to choose to engage in a subsequent joint activity, thus demonstrating increased cooperative motivation. Our findings extend prior work by demonstrating that children who display more friendly and interaction-supporting behaviors during a warm-up with an unfamiliar same-aged peer may be more motivated to cooperate, and thus take the role of the initiator within a cooperative interaction.

Warm-up affiliation was not linked with children's responding or success. However, the mechanisms underlying the roles within the cooperative exchange could provide a potential explanation for this divergent effect. The lack of associations between warm-up affiliation and cooperative ability are in line with findings by Schuhmacher and Kärtner (2015) who did not report an effect of positive behaviors and levels of coordination within a cooperative task. We reported children's initiating and responding with the goal of tapping into cooperative motivation and coordination, respectively. Thus, our research compliments that of Schuhmacher and Kärtner (2015) by suggesting that increased displays of warm-up affiliation before rapport is established is associated with increased cooperative task motivation (i.e., initiating), but not coordination (i.e., responding).

Together with the findings of Schuhmacher and Kärtner (2015), our findings suggest that positive impression formation with a previously unfamiliar same-aged peer may shape children's subsequent choices to lead cooperative interactions, or be motivated to cooperate with the same social partner. However, this initial impression formation did not appear to facilitate enhanced spatial coordination abilities. Our findings build on this prior work by extending the generalisability of Schuhmacher and Kärtner's findings to include two-year-olds. Additionally, our research suggests that affiliation that is displayed before rapport is established may be particularly important in facilitating cooperative outcomes when social partners have limited verbal abilities (Haslett & Samter, 1997).

A second piece of evidence supporting spill-over across tasks comes from our

finding that children's increased contribution to the toy clean-up predicted an increased likelihood of responding, but not initiating. These findings align with previous research suggesting that children who engage in reciprocity-based tasks with an experimenter (i.e., a warm-up interaction or rolling a ball back and forth) are more likely to respond to the experimenters bids for help in a subsequent task (Barragan & Dweck, 2014; Schuhmacher et al., 2019). Our findings extend prior work by offering support for the spill-over of coordination behaviors in another prosocial domain, cooperation, and with a different cooperative partner, a same-aged peer. Perhaps most importantly, these findings offer evidence against the hypothesis that altruism occurs naturally (Tomasello, 2009) and instead suggests that prosocial behavior is a result of the social situation (Barragan & Dweck, 2014). Although increased contribution scores predicted a decreased likelihood of cooperative task success, this effect was not practically significant. Further research is needed to clarify the extent to which familiar joint activities influence future cooperative task success.

As expected, we did not observe significant effects of antagonism during the warm-up on subsequent cooperative ability. These findings are consistent with findings by Endedijk et al. (2015), which did not reveal links between antagonism and cooperative ability. Together, these findings suggest that antagonism neither hinders nor supports cooperative ability between peer dyads, which are somewhat surprising given the nature of antagonistic behavior (i.e., competitive and unsupportive). However, in our sample, warm-up antagonism occurred at low rates (e.g., 10% to 25%; see Table 3) which raises the possibility that warm-up antagonism might adversely impact cooperative ability if it occurred at increased frequency or intensity. This is a question that future work could explore, perhaps by adapting the warm-up task to fuel antagonism more readily (e.g., conducting a frustration task).

Somewhat unexpectedly, warm-up JCE was not associated with cooperative outcomes. This could be due to the absence of high-level warm-up JCE that was discussed previously. However, more research is needed to examine spill-over effects, particularly in cases where high JCE is elicited.

We did not generate specific hypotheses regarding associations between our measures at the beginning and the end of the warm-up interaction, aside from identifying these time points as being important for differentiating between rapport status. However, it was surprising that none of the warm-up B2 interaction quality measures significantly predicted children's cooperative performance. This could be due to interference from the toy clean-up phase of the warm-up, which took place during the majority of B2. Perhaps the dyads' attention was focused on contributing to the toy clean-up, rather than on engaging socially, and thus they failed to "keep in mind" the interaction quality information during that period of time. Support for this explanation stems from research which suggests that toddlers demonstrate difficulty generalizing information across contexts, perhaps due to low working memory capacities (Barr et al., 2016; Choi, Kirkorian, & Pempek, 2018). Although much of this research assesses learning deficits through varying media (e.g., books and digital), it is possible that this deficit exists in everyday, social contexts as well. However, more research is needed to offer insight into the stability of such links.

Exploratory Analyses

To test if any one measure of interaction quality exerted an effect on the other measures of interaction quality within the cooperative task, we utilized the same statistical tests as in the Focal Analyses section. Estimates, standard errors, and Wald statistics for all models can be found in Table 4.

We conducted two GEE tests with cooperative task JCE and affiliation or antagonism as predictors of affiliation or antagonism. Additionally, we generated a LMM with affiliation and antagonism as predictors of cube root transformed JCE. Results revealed that affiliation predicted a 118% increase in the likelihood of antagonism and a 27% increase in the likelihood of increased JCE. Additionally, increased JCE predicted a 366% increase in the likelihood of affiliation and 77% increase in the likelihood of antagonism. No additional significant results emerged.

Unexpectedly, cooperative task affiliation predicted an increased likelihood of antagonism. It is possible that children initially displayed affiliation to facilitate the

cooperative exchange, but then became frustrated with the task and their social partner when they were unable to achieve the shared goal which resulted in increased displays of antagonism. More research is needed to understand how the timing of cooperative task affiliation and antagonism interact with and impact one another.

Affiliation predicted an increased likelihood of JCE. Although the present study is the first to explore the effects of affiliation on JCE within a cooperative task, the results are generally in line with evidence that children who demonstrate increased intention understanding, as measured implicitly via an eye-tracking paradigm, are more likely to be affiliative during cooperative exchanges (Hunnius et al., 2009). Our finding builds on this work by demonstrating that increased affiliation may be associated with explicit measures of children's ability to interpret their social partner's intentions and modify their behaviors accordingly (i.e., JCE) within cooperative contexts. One question this finding raises is in regards to the directionality of the effects. More research is needed to determine if affiliation gives rise to JCE, or vice versa. Our future research will examine this by assessing the impact of timing on children's behaviors within a cooperative exchange.

Increased JCE predicted an increased likelihood of affiliation and antagonism. This is in line with previous research which suggests that the ability to attend and react to others' is a keystone in conveying one's intentions and understanding the intentions of others (Bratman, 1992; Hunnius et al., 2009). Our findings extend this research by suggesting that children's social-cognitive abilities may also be critical in facilitating non-cooperative and cooperative intentions. More research is needed to determine the effects of JCE on children's social behaviors across contexts extending beyond cooperation (e.g., competitive).

Antagonism did not predict affiliation or JCE. This is consistent with research by Endendijk et al. (2015) who did not observe associations between antagonism and cooperative outcomes. Additionally, the low incidence of antagonism, particularly compared to affiliation (see Table 3), could account for why antagonism did not exert effects on other interaction quality measures.

Results Summary

See Figure 2 for a summary of the significant findings described above. In sum, results from our focal analyses provided mixed support for our hypotheses. Warm-up interaction quality did not predict cooperative task interaction quality, suggesting that identical behaviors do not spill-over and thus, may serve to convey context specific intentions. However, the warm-up interaction quality, specifically affiliation in the first block of the warm-up and children's contribution to the toy clean-up at the end of the warm-up, predicted children's increased cooperative task initiating and responding, respectively. Thus, our findings suggest that social behaviors elicited in an initial interaction may spill-over to the subsequent interaction, but the effects shape cooperative behavior rather than further social behaviors. Importantly, initial affiliation may facilitate cooperative motivation while increased contribution to a joint activity may facilitate future coordinated behavior. These findings extend prior work with older children by providing evidence that impression formation shapes two-year-olds' cooperative performance.

Our exploratory analyses revealed that affiliation exerted an indirect effect on cooperative ability through JCE. Children who engaged in increased affiliation also tended to demonstrate increased JCE, and increased JCE predicted increased initiating and responding. Thus, affiliative children may utilize their intention understanding skills, as evidenced by enhanced JCE, and thereby show enhanced cooperative motivation (i.e., initiating) and coordination (i.e., responding), but not success, within cooperative exchanges. Overall, our findings suggest that affiliation may promote children's ability to coordinate their attention and actions with their social partner, which in turn promotes behaviors that support cooperative ability. However, given the exploratory nature of these findings and the lack of clarity regarding the directionality of the association between affiliation and JCE, more research is needed to investigate these effects, particularly when the goal is not achieved.

Existing evidence suggests that preschool-aged children who are more affiliative towards one another are more likely to be successful in achieving a shared goal during a cooperative interaction (Endedijk et al., 2015). While these findings demonstrate the important role that positive and supportive behaviors play in shaping cooperative outcomes, they raise questions concerning the extent to which children's impression formation shapes subsequent cooperative interaction quality and outcomes. The present research addressed these questions by investigating whether the quality of an interaction between two unfamiliar, same-aged two-year-old children during an initial warm-up period predicted both the interaction quality and cooperative performance demonstrated by the dyad during a subsequent cooperative task.

The cooperative interaction quality did not predict cooperative ability. Other than their contribution to the toy clean-up, children's warm-up social behaviors did not inform their cooperative task social behaviors. However, children who were affiliative during the early part of the warm-up were more likely to engage in bids for cooperation, but no more likely to respond to their social partner's bids for cooperation. Children who contributed more efficiently to cleaning up the toys at the conclusion of the warm-up were more likely to respond to their social partner's goal-oriented actions during the cooperative task. Exploratory analyses suggested that while antagonism did not predict other interaction quality behaviors within the cooperative task, children who displayed affiliation were more likely to engage in antagonism and JCE. Further, children who engaged in increased cooperative task JCE were more likely to display affiliation and antagonism. Importantly, exploratory analyses suggested that cooperative task affiliation may exert an indirect effect on children's cooperative behaviors via JCE. Taken together, the results of this study provide insights into how previously undocumented social behaviors that unfold naturally as part of experimental protocols (e.g., affiliation or joint clean up) may confound studies that aim to investigate social behaviors. Critically, our findings indicate that social interactions in one context may be used to predict behaviors in other context, thereby supporting the notion that research may predict social compatibility and cooperative outcomes based on initial intradyadic behavior.

The findings provided by the present study offer implications for future research by demonstrating that initial social interactions may impact experimental outcomes. Although this is one study that examined the effects of 23-month-olds dyads' social interactions on cooperative behavior, prior work demonstrating an impact of initial synchronized movement between four-year-old peers on cooperative behavior (Rabinowitch & Meltzoff, 2017b) and reciprocal behavior in a warm-up interaction between adult-child dyads on one- and two-year-olds' helping and sharing behavior (Barragan & Dweck, 2014) suggest similar spill-over effects. This growing body of consistent evidence highlights the importance of considering social interactions beyond

experimental paradigms; thus, we offer suggestions for steps researchers could consider when designing such studies below.

First, researchers could design study protocols so that any warm-up or social interactions, beyond the experimental task, are documented, ideally via video recordings, and available for offline coding. Conducting offline coding would be the most comprehensive step that researchers could implement to test for potential spill-over effects across social interactions. However, environmental, ethical, or budgetary restrictions may hinder a researcher's ability to record or complete detailed offline coding of initial interactions. In these cases, researchers could design study protocols, beginning with detailed consent and warm-up procedures to be systematic and controlled across participants. For example, protocols could include behavioral guidance for unstructured warm-up interactions which suggest that experimenters refrain from potentially relevant behavior such as being too affiliative or cooperative with the child or encouraging peer dyads to be too affiliative or work together prior to an experimental task. Systematic protocols with behavioral guidance criteria would enable unstructured tasks to remain flexible and fulfill their experimental purpose while ensuring that confounding social behaviors are not introduced into the study. Humans are inherently social beings and, consequentially, are impacted by the micro-dynamics of social interactions. While our suggestions are based upon findings from child populations within the domain of prosocial behavior, researchers designing protocols through which to study broader social interactions and behaviors may benefit by implementing the actions listed above.

Strengths, Limitations and Future Directions

The present research is the first to suggest that first impression formation through interaction quality predicts aspects of cooperative outcomes in children younger than two years of age. However, some features of the present research limit generalizability. Critically, the present research was not designed to test causality and therefore lacks a control condition. Given this, the present study cannot speak to the extent to which initially interaction quality *causes* subsequent cooperative interaction quality or ability.

Additionally, in the study by Brownell et al. (2006), only 14% of similar-aged dyads failed to successfully achieve the cooperative goal compared with 56% of the dyads in our study. This suggests that the age range of children in our study found our version of the parallel roles cooperative task particularly challenging. It remains unknown if the task difficulty impacted our findings by exerting a confounding effect on children's interaction quality behaviors. Future research examining longitudinal effects may provide further insights into this question.

More research is needed to assess the stability of and the mechanisms underlying our findings. Our future work will examine how these children perform longitudinally on similar tasks with unfamiliar peers and thus, will provide insights into the extent to which children's interaction quality and cooperative ability measures are stable across time. This work will offer evidence into whether, or not, the lack of noteworthy findings regarding the interaction quality at the end of the warm-up task and cooperative task ability were a result of limited working memory and context generalizability capacity.

Conclusion

Interactions between individuals do not exist in a vacuum. Social situations, interaction quality, and joint experiences between cooperative partners shape the social dynamic and impact how well dyads are able to successfully attain a shared goal. Our findings suggest that behaviors that facilitate cooperative outcomes may indirectly affect children's cooperative abilities by supporting children's socio-cognitive abilities, however more research is needed to determine the direction of this effect as it is possible that children's socio-cognitive abilities underlie their displays of social behaviors. Interaction quality does not appear prone to spill-over across tasks and thus, children's social behaviors in goal-driven contexts may be goal specific rather than general. However, interaction quality does spill-over to subsequent task performance. Specifically, the interaction quality observed when unfamiliar peers first meet fosters cooperative outcomes by enhancing cooperative motivation. Engagement in a joint activity prior to cooperating in a novel task enhances children's ability to respond to their social partner. These findings challenge the idea that humans are naturally

prosocial. Future research should consider these findings when designing studies as to minimize the social effects of interaction quality and first impression formation on prosocial behaviors throughout development.

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