The Relationship Between Parental Responsiveness and Infant Social-Cognitive Behaviors in Infancy and Toddlers' Joint Attention

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Abstract

Joint attention, also known as joint engagement, is defined as the ability to coordinate attention between a social partner and an object or event of shared interest. Joint attention occupies a central position in children's developmental research and has been shown to be crucial for language development, communication, and other advanced social skills. However, influences on the development of joint attention are not well understood. In this longitudinal honors thesis, we examined in 89 dyads how infant social-cognitive behaviors (i.e., triadic engagement, communicative vocalizations, and face looks) and caregiver responsiveness at 9 to12 months of age was associated with later joint engagement skills at 18 or 24 months old. Results showed that infant social-cognitive behaviors at Time 1 were significantly associated with some aspects of toddler joint engagement at Time 2; however, caregiver responsiveness was not. Future research should continue exploring the effects of individual differences in infancy and caregiver behavior on the development of joint attention in toddlerhood.

Keywords: joint attention, responsiveness, longitudinal, infancy, toddlerhood

The Relationship Between Parental Responsiveness in Infancy and Toddlers' Joint Attention

The ability to coordinate attention between a social partner and an object or event of shared interest, known as joint attention, is an early developmental achievement that is important for social cognition and behavior (Akhtar & Gernsbacher, 2007; Baldwin, 1995; Stout et al., 2020). In particular, joint attention is crucial to language development, communication, problem solving, theory of mind, and social-cognitive processes used in social interactions (e.g., perception, attention, memory, and action planning) (Frith, 2008; Mundy, 2016). Many studies have examined the development of joint attention in infancy by examining infants' joint attention with a caregiver, an experimenter, or peers (e.g., Bakeman et al.,1984; Gaffan et al., 2010; Osório et al., 2011). Although much is known about the various milestones that occur during joint attention development (e.g., Carpenter et al., 1998; Mundy et al., 2007), less is known about the mechanisms by which joint attention develops and what explains individual differences in that process. The goal of the current study was to examine the role of early caregiver behavior in the development of joint attention. In particular, we examined how variability in caregiver responsiveness in infancy longitudinally predicts joint attention skills in toddlerhood.

Joint Attention

One prominent approach to the study of the development of joint attention has been to characterize the ways in which a child actively attends to a shared topic, event, or idea with a social partner during the course of naturalistic interactions (e.g., Bakeman & Adamson, 1984; Adamson & Dimitrova, 2014; Adamson et al., 2004). Researchers have identified several different types of "joint engagement states" that occur in ongoing social interactions that can be differentiated based on the role of the child and the social partner in that interaction.

The earliest form of joint engagement is seen in infants as young as 4 to 6 months old. At this age, parents tend to be a child's literal support in sustaining and attracting mutual attention (Adamson & Ditrova, 2014). In this type of engagement, for example, a parent may move a block back and forth in front of their child in order to gain their engagement. This is known as *supported joint engagement*. Supported joint engagement occurs when an infant and their caregiver are actively involved with the same object (Bakeman & Adamson, 1984), but the infant has very little awareness of the caregiver's involvement with the object and the social interaction (Bakeman & Adamson, 1984).

Between the ages of 9 and 12 months old, infants increasingly respond to their social partners' joint attention acts using object-directed communicative acts such as pointing and showing (Morales et al., 2000). At this age, the onset of another state, *coordinated joint engagement*, also occurs. Coordinated joint engagement involves a child who is able to focus

on a shared object or event while actively attending to or recognizing their

social partner (i.e., gazing towards a social partner, head turning, pointing

gesture) (Adamson & Dimitrova, 2014; Tomasello & Carpenter, 2007).

Additionally, during this portion of joint attention development, infants

begin to use affective expressions, vocalizations, and simple words in their

interactions (Adamson et al., 2004). By 18 months of age, it is said that the

foundation behind joint attention is consolidated. That is, infants are said to

have not only mastered the skills behind responding to and initiating joint

attention (i.e., gaze following, pointing, showing, manipulating), but they

are also able to sustain periods of cooperative communication and

collaborative action (i.e., joint engagement) during social interactions

(Tomasello & Carpenter, 2007).

By 18 months old, children begin to expand their joint-attentive

interactions by incorporating language (either expressive or receptive) and

symbolic gestures (Adamson, 1995). This form of joint attention, known as

symbol-infused joint engagement, eventually leads to children being able to

include memories, plans, mental states (i.e., desires and beliefs), and

imaginary events into shared topics and interactions. In a longitudinal

investigation of symbol-infused joint engagement, Adamson, Bakeman, and

Deckner (2004) showed that the proportion of time children spent in

symbol-infused joint engagement with their caregivers increased

significantly from 18 to 24 months of age, with the greatest increase being

between the ages of 21- 24 months old. Moreover, results showed that

typically-developing toddlers varied considerably in both the timing and the trajectory of symbol-infused joint engagement development. These results suggest that the toddler years are a key time for the development of advanced forms of joint engagement.

In addition to documenting the different forms of joint engagement and how they develop across the first few years of life, research has also examined the extent to which individual differences in children's early joint engagement are related to individual differences in later joint attention and other-social cognitive abilities. For example Mundy et al. (2007) found stability in individual differences in joint attention from 9- to-18-months. Additionally, Adamson et al. (2017) found that joint engagement during parent-child interactions predicted expressive language and vocabulary skills in toddlers with Autism Spectrum Disorder (ASD) and Developmental Disabilities (DD). In addition, Nelson et al. (2008) showed that toddlers who spent more time in coordinated joint engagement between 18 and 21 months of age showed better subsequent theory of mind scores as preschoolers. Additionally, toddlers who spent more time in symbol-infused joint engagement between the ages of 27 and 30 months also showed better preschool theory of mind scores. Together, these findings suggest that joint engagement from an early age is an important factor for later joint-attention behaviors, language acquisition, and theory of mind development.

Joint Attention and Caregiver Interactions

Because of the importance of joint attention in infants' and toddlers' later lives, researchers have begun to explore what factors positively influence its development. One line of research suggests that caregiver behavior, specifically parent scaffolding (i.e., the way in which a parent guides a child's learning process by offering support at different levels throughout their social interaction) (Crockett & Hayes, 2011) and caregiver responsiveness (i.e., the extent to which caregivers respond contingently, appropriately, and promptly to their infant's signals) (Bornstein et al., 2008) are important to this process.

Previous research has shown that caregiver behavior shapes a variety of developmental outcomes including attachment styles (Raval et al., 2001) and language development (Adamson et al., 2017; Tamis-LeMonda & Bornstein, 2002). More recently, three groups of researchers have been examining how caregiver behaviors influence the development of joint attention in the infant and toddler years (Fadda & Lucarelli, 2017; Gaffan et al., 2010; Vaughn et al., 2003).

For example, Fadda & Lucarelli (2017) investigated the effect of early child-mother interactions during play on children's later communication skills during play with an unfamiliar social partner (i.e., the experimenter). Results showed that infants whose caregivers showed high quality/more functional interactions (i.e., reciprocated play in a non-intrusive manner) during their free-play session had children who showed better joint attention with an experimenter. This pattern was observed both when

caregiver behavior and joint attention were measured concurrently and longitudinally when joint attention was observed 6 months later. This finding suggests that a relationship does exist between caregiver behavior and children's joint attention development.

Gaffan and colleagues (2010) and Vaughn et al. (2003) also set out to examine how more specific types of caregiver behavior during an infant's early months influence their joint attention a few months later. Gaffan et al. (2010) found both cross-sectional and longitudinal associations between caregiver behaviors and infant joint attention skills. More specifically, infants whose caregivers were more sensitive (i.e., responsive) and showed more teaching behaviors (i.e., pointing, demonstrating, verbal directives, guiding) in play interactions at six months of age spent more time in joint attention at nine months of age. Similarly, Vaughn et al. (2003) found that caregiver scaffolding (i.e., showing and demonstrating how objects work in interactions) at both 9 and 12 months was significantly associated with infants' joint attention with a third party at 12 months. Together, these studies illustrate that natural variability in caregiver-infant interactions is related to infant joint attention, suggesting that caregiver behavior likely plays a role in the development of joint attention in infancy.

A distinct but related line of work has looked at how interventions related to caregiver responsiveness can improve joint attention outcomes in neurodivergent toddlers, especially those diagnosed with Autism Spectrum Disorder (ASD) (e.g., Adamson et al., 2017, Kasari et al., 2006, Kasari et al.,

2008, Kasari et al., 2010, Kasari et al., 2015). Intriguingly, these interventions have shown that changing parent-child interactions can impact children's joint attention. One group of researchers, Kasari et al. (2015), assigned parent-toddler dyads to receive 10 weeks of hands-on parent training in joint attention, symbolic play, and engagement and regulation (JASPER). In learning how to implement JASPER, caregivers were coached by a trained interventionist on how to rearrange and adjust the child's environment to provide optimal opportunities for sustaining joint engagement within social interactions (Kasari et al., 2015; Mundy, 2007). Additionally, caregivers learned how to increase joint attention gestures and play skills by "commenting on objects of interest, imitating actions, modeling elaborations of actions, and modeling functional language in a manner that the child can learn from, without redirecting or recruiting the child's attention" (Mundy, 2007). Results showed that following the intervention, caregivers were significantly more effective at engaging their children in play and sustaining joint engagement. Additionally, the intervention illustrated significant increases in the number of child-initiations of joint engagement with an experimenter. The effects of the intervention were maintained 6 months post-intervention. This study lends support to the hypothesis that responsive caregiver behaviors that maintain children's focus of attention can play a causal role in children's joint engagement development.

Each of these studies clearly shows that caregiver behaviors are important to the development of an infant's joint attention abilities. However, there are some discrepancies across these studies, making it unclear as to what the conclusions should be. For example, findings from Gaffan et al. (2010) and Vaughn et al. (2003) suggest that caregivers should play a more active and directive role in interactions with their children in order to facilitate joint attention (e.g., showing an object, pointing to an object, or demonstrating how an object works). On the other hand, Kasari et al. (2015) propose that more passive and responsive approaches, such as commenting on an object in the child's focus of attention or following a child's initiations, promote higher joint attention. Thus, more work is needed to determine how caregiver behaviors and involvement in interactions with their children positively contribute to joint attention development.

The Current Study

Overall, existing research on the development of joint attention in infancy suggests that variability in caregiver behaviors predicts variability in joint engagement during infancy. However, less is known about the role of caregiver responsiveness (i.e., the extent to which caregivers respond contingently, appropriately, and promptly to their infant's signals), in particular, in the development of joint attention. Additionally, past research has produced conflicting results; while some studies have concluded that more active and directive caregiver approaches (e.g., showing an object,

pointing to an object, or demonstrating how an object works) produce better joint engagement, other studies have demonstrated that more passive and responsive caregiver approaches (e.g, such as commenting on an object in the child's focus of attention or following a child's initiations) produce better joint engagement. Finally, existing studies linking caregiver behavior and infant joint attention rarely span from infancy to toddlerhood, raising questions about how early infant-caregiver interactions set the stage for critical joint attention developments in the toddler years.

Thus, the goal of this study was to examine the longitudinal relations between caregiver responsiveness in infancy and joint attention skills during the toddler years among neurotypical children. The current study examined these relationships using a longitudinal design. At Time 1 (age 8 to 12 months), we examined caregiver responsiveness during an 8-minute infant-caregiver free play interaction. At Time 1, we also assessed infants' early social-cognitive abilities, including attention to their caregiver during free play and both triadic engagement and communicative vocalization with an experimenter. Then at Time 2 (age 18 to 24 months), we examined toddlers' joint engagement skills during a 5-minute free play interaction with their caregiver. Specifically, we examined total joint engagement (TJE), coordinated joint engagement (CJE), and symbol-infused joint engagement (SJE) with the caregiver at Time 2.

Consistent with the interventions designed by Kasari and colleagues (Kasari et al., 2006, Kasari et al., 2008, Kasari et al., 2010, Kasari et al.,

2015), we predicted that variability in caregiver responsiveness in infancy

longitudinally predicts joint attention in toddlerhood such that caregivers

who are more responsive to infants' focus of attention at Time 1 have

children who go on to have better joint attention skills as toddlers at Time 2.

We expected these effects of caregiver responsiveness to be clearest in the

CJE and SJE measures given that these represent more sophisticated forms

of joint attention that are likely to vary significantly at the toddler time

point. We also hypothesized that infants who show better social-cognitive

abilities at Time 1 (e.g., greater attention toward their caregiver during

play, more bouts of triadic engagement, and more communicative

vocalizations), will be more jointly engaged as toddlers at Time 2. Overall,

this study is expected to provide important insight into how infant social-

cognitive abilities and caregiver responsiveness in infancy support joint

attention development during the toddler years.

Method

Participants

Participants in the current study were drawn from a larger set of

studies independently exploring social-cognitive abilities in infancy (N =

216; Time 1), and prosocial behavior in the toddler years (N = 189; Time 2).

Of these participants, 89 provided data at both time points; these children

(41 females, 48 males) served as the focal sample for the current study.

During the infant lab visit (Time 1), participants ranged in age from 8 to 12

months (M = 9.33 months, SD = 1.0). During the toddler lab visit (Time 2),

children were either 18 months (N = 34) or 24 months (N = 54) of age (M =

22.5 months, SD = 3.1). The time between visits varied from 8 to 17 months

(M = 13.1 months, SD = 3.0). Parents identified the participants as

predominantly White (77% White, 8% Hispanic or Latino, 1% Black or

African American, 11% selected two or more races/ethnicities, 3% did not

respond) and of middle-class homes (7% reported a household income of

less than $35,000; 8% $35–52,000; 20% $52–74,000; 33% $74–122,000;

27% $122,000 or greater; 6% did not respond).

Participants were recruited using birth records and a database of

families interested in participating in developmental research in a midsize

city in the Northeastern United States. All procedures in the present study

were approved by the Institutional Review Board at Lehigh University.

Measures and Procedures

The current study focused on caregiver responsiveness during an 8-

minute free play session with the caregiver at Time 1, infant social-cognitive

abilities demonstrated with the caregiver and an experimenter at Time 1,

and toddler joint attention during a 10-minute free play interaction with the

caregiver at Time 2. Time 1 coding of caregiver responsiveness and infant

social cognition was completed by researchers in the Cognitive

Development Lab. Time 2 toddler joint attention was coded for the purpose

of this study.

Time 1 Measures of Caregiver Responsiveness

At their initial lab visit at 8 to 12 months of age, infants and caregivers completed an 8-minute free play interaction. The caregiver and infant were seated on a carpet and presented with a variety of toys (e.g., blocks, cups, caterpillar, tambourine with a mirror). Caregivers were asked to play with their infant as they normally would at home; these sessions were video recorded for subsequent coding.

Infant-caregiver interactions were coded for caregiver responsiveness using Datavyu (Datavyu Team, 2014). In the first stage of coding, coders identified the onset and offset of all caregiver object-directed actions. These included caregivers deliberately manipulating, engaging with, or gesturing towards an object in the infants' play space (e.g., stacking blocks, pointing at the caterpillar, shaking the tambourine). The onset of each object-directed action was marked as the video frame in which the caregiver's hand makes initial contact with the target object or begins the gesture or pointing action; the offset was marked as the video frame in which the caregiver either breaks contact with the object for at least 3 seconds, switches to a new object, or ends the gesture or pointing action.

In the second stage of coding, coders characterized whether each object-directed action was responsive to the infants' actions or focus of attention. A 3-second window was used prior to the onset of each caregiver object-directed bout to determine the infant's actions. If the infant was physically engaged with, reaching for, or pointing at the object of the caregiver's subsequent object-directed action, the caregiver action was

coded as *maintaining* the baby's focus of attention. If the infant was physically engaged with, reaching for, or pointing at a different object, the caregiver action was coded as *redirecting* the baby's focus of attention. Lastly, if the infant was neither physically engaged with, nor reaching for or pointing at any object present, the caregiver's response was categorized as *introducing* an object into the baby's focus of attention. Given that caregiver responsiveness includes caregiver behaviors that respond contingently and appropriately to cues from the infant, for the purpose of the current study, caregiver maintaining actions were considered responsive while caregiver redirecting actions were not (Landry et al., 1996). Thus, caregiver responsiveness was defined as the relative proportion of maintaining actions to maintaining and redirecting actions.

Time 1 Measures of Infant Social-Cognitive Behaviors

During their Time 1 visit, infants' social-cognitive behaviors were also assessed. During the above free play interaction, infant *social attention towards their caregiver* was observed. Coders counted the number of times the infant looked at their caregiver's face as the measure of social attention toward the caregiver.

Infant joint attention with an experimenter was also assessed during the Time 1 visit. Infant's *triadic engagement* with the experimenter was assessed during a 2-minute, semi-structured play session in which the infant was seated across from the experimenter at a table. The task began after the experimenter arranged a set of 4 toys on the table in front of the infant.

The experimenter subsequently engaged the infant with one of four toys every 30 seconds. During the remainder of the play session, the experimenter was instructed to sit neutrally and respond to the infant only when the infant looks to her in the face (responses from the experimenter included positive facial expressions, nodding, and brief verbal comments). Coders identified the total number of bouts of triadic engagement, defined as gaze shift from an object to the experimenter's face and back to the same object. The same 2-minute play session was also used to assess *infant communicative vocalizations*. Coders identified the total number of vocalizations made by infants while making eye contact with the experimenter at any point during the task.

Time 2 Measures of Toddlers' Joint Attention Skills

At their second lab visit at 18 or 24 months, toddlers and caregivers completed either a 5-minute ($N = 37$) or 10-minute ($N = 53$) free play interaction. The caregiver and toddler were seated in a room with a small table and a variety of toys (e.g., shape sorting box, farm with animals, xylophone, stacking caterpillar). Caregivers were asked to play with their toddler as they normally would at home.

Videos of these toddler-caregiver free-play interactions were coded for toddlers' joint attention skills using Datavyu. The toddler joint attention coding scheme implemented here was inspired by a subset of scales from the Joint Engagement Rating Inventory (JERI) (Adamson et al., 2020). The JERI was originally developed to provide items that help characterize joint

engagement, communication dynamics, and shared topics in Autism, Down syndrome, and typical development. Currently, the JERI is being used to study early joint engagement and communication development using 32 rating items. Each item within the inventory corresponds to the child's joint engagement state, the child's behavior within a social interaction, or the caregiver's behavior within a social interaction, and is coded on a 7-point scale based on the totality of the interaction.

In the current study, the JERI enabled researchers to measure toddlers' joint engagement and individual differences in joint attention. To provide a more precise assessment of toddlers' joint attention behaviors, we first separated the 5- or 10-minute interactions into 60-second segments. Researchers then watched the first 5 segments of each video and rated the following three items from the child's engagement state subscale: total joint engagement, coordinated joint engagement, and symbol-infused joint engagement. Each engagement state was coded using a modified 7-point scale. *Total joint engagement* (TJE) occurred when a child actively engaged with the same object or event that their caregiver was attending to. *Coordinated joint engagement* (CJE) occured when the toddler and caregiver were actively involved with the same object or event and the child actively and repeatedly acknowledged the caregiver's participation via face looks and/or direct verbal engagement. Lastly, *symbol-infused joint engagement* (SJE) occurred when the child and caregiver were actively involved with the same object/event and the child was gesturing, using

descriptive words, or responding to their caregiver's directives (see

Appendix for the full coding scheme). Toddlers' average TJE, CJE, and SJE

score serve as the focal measures of joint attention for the current study.

Results

Descriptive Statistics

Descriptive statistics for the Time 1 and Time 2 variables of interest

are presented in Table 1. As can be seen in Table 1, caregiver behaviors

varied considerably across dyads. Caregiver responsiveness, defined as the

relative proportion of caregiver maintaining actions to caregiver

maintaining and redirecting actions, showed an average of .54, meaning

that caregivers spent a little more than half of their bouts with their infants

maintaining the infant's focus of attention. However, caregiver

responsiveness varied across the sample. Notably, one caregiver showed a

caregiver responsiveness value of 1.00, indicating that all their bouts

maintained the infant's focus of attention, while another caregiver showed a

caregiver responsiveness value of 0.00, indicating all their bouts redirected

their infants' focus of attention. We also saw variability in infant social-

cognitive behaviors at Time 1, with infants differing considerably in the

number of looks made to the caregiver during free play, bouts of triadic

engagement with the experimenter, and communicative vocalizations to the

experimenter (see Table 1). Infant age was not significantly related to

caregiver responsiveness nor any infant social cognitive behaviors (all $ps >$

0.07).

Descriptive statistics illustrating toddlers' joint engagement at Time 2, which varied considerably across toddlers, are also provided in Table 1. As can be seen there, toddlers showed a mean joint engagement score of 4.00 (SD = 1.10), indicating that toddlers were actively engaged with the same object as their caregiver for approximately half of the play session. Toddlers showed a mean coordinated joint engagement (CJE) score of 1.81. This indicates that toddlers looked at their caregiver's face or referenced their caregiver verbally within joint engagement an average of once during each minute of the task. Additionally, toddlers showed a mean symbol-infused joint engagement (SJE) score of 2.84, indicating that they utilized gestures, descriptive language, and/or responded to their caregiver's verbal directives within joint engagement an average of two to three times during each minute of the task. Lastly, toddler joint engagement was significantly related to toddler age at Time 2: TJE: $r(87)$ = 0.31, p = 0.004; CJE: $r(87)$ =0.26, p = 0.015; SJE: $r(87)$ = 0.56, p < 0.001.

Table 1. Descriptive statistics for Time 1 and Time 2 (including observed means, standard deviations, and ranges for each caregiver and child variable of interest)

	Mean	Sd. Deviation	Minimum	Maximum
T1 Total Caregiver Maintaining Bouts	12.40	6.68	0.00	33.00
T1 Total Caregiver Redirecting Bouts	10.62	6.34	0.00	30.00
T1 Caregiver Responsiveness	0.54	0.21	0.00	1.00
T1 Face Looks to Caregiver	11.63	8.57	1.00	40.00
T1 Triadic Engagement with Experimenter	2.56	1.70	0.00	7.00
T1 Infant Vocalization to Experimenter	1.12	2.11	0.00	14.00
T2 Toddler Total Joint Engagement (TJE)	4.00	1.10	2.20	6.60
T2 Toddler Coordinated Joint Engagement (CJE)	1.81	0.79	1.00	4.00
T2 Toddler Symbol-Infused Joint Engagement (SJE)	2.84	1.12	1.00	6.60

Correlations between Time 1 and Time 2 Measures Controlling for Toddler Age

Next we examined the longitudinal relations between the Time 1 variables (caregiver responsiveness, infant face looks to caregiver, triadic engagement, infant communicative vocalizations) and Time 2 toddler joint engagement (TJE, CJE, SJE) while controlling for toddler age (see Table 2). Contrary to our hypothesis, Time 1 caregiver responsiveness was not significantly related to toddler joint engagement at Time 2 (TJE: $r(86) = .09$, $p = 0.43$; CJE: $r(86) = -0.01$, $p = 0.90$; SJE: $r(86) = 0.08$ $p = 0.48$). However, infant social-cognitive behaviors at Time 1 were significantly related to some aspects of toddler joint engagement at Time 2. Specifically, infants who gave more face looks to their caregivers at Time 1 showed significantly higher TJE ($p = 0.032$) and CJE ($p = 0.004$) scores as toddlers at Time 2. Likewise, infants who engaged in more bouts of triadic engagement at Time 1 showed marginally higher TJE ($p = 0.055$) and CJE ($p = 0.055$) scores, and significantly higher SJE scores ($p = 0.026$) as toddlers at Time 2. Lastly, infants who vocalized more to the experimenter at Time 1 showed marginally high TJE ($p = 0.070$) and significantly high SJE scores ($p = 0.025$) at Time 2.

Table 2. Partial correlations between T1 and T2 measures (controlling for toddler age).

| Time 1 Infant Measures | Total Joint Engagement (TJE) | Time 2 Toddler Joint Engagement | |
		Coordinated Joint Engagement (CJE)	Symbol-Infused Joint Engagement
Caregiver Responsiveness	0.087	-0.014	0.079
Infant Face Looks to Caregiver	0.236*	0.316**	0.151
Infant Triadic Engagement with Experimenter	0.208+	0.207+	0.239*
Infant Vocalization to Experimenter	0.199+	0.171	0.244*

*p < .05, ** p < .01, *** p < .001

Note. Conditioned on variables: Toddler Age

Hierarchical Regression Analyses

Finally, we conducted a series of hierarchical regression analyses predicting Time 2 toddler joint engagement from Time 1 caregiver responsiveness, Time 1 infant social-cognitive abilities, and Time 2 age. Separate regression models were built for each measure of toddler joint engagement: TJE, CJE, SJE. Only the Time 1 infant social-cognitive abilities that reached significance in the partial correlation analyses (see Table 2) were included in the analyses, and each regression included only a single measure of Time 1 infant social-cognition. Thus, four regression models in total were conducted. Model 1 assessed the effects of Time 1 caregiver responsiveness, Time 1 infant face looks to the caregiver, and Time 2 age on Time 2 toddler TJE. Model 2 assessed the effect of Time 1 caregiver responsiveness, Time 1 infant face looks to the caregiver, and Time 2 age on Time 2 toddler CJE. Model 3 examined the effects of Time 1 caregiver responsiveness, Time 1 infant triadic engagement with the experimenter, and Time 2 age on Time 2 toddler SJE. Finally, Model 4 examined the effects of Time 1 caregiver responsiveness, Time 1 infant vocalizations, and Time 2 age on Time 2 toddler SJE. Across all four regression analyses, the Time 1 infant social-cognitive abilities ($\beta s > .20$, $p s < .025$) and Time 2 age ($\beta s > .31$, $p s < .005$) significantly predicted Time 2 toddler joint

engagement. However, Time 1 caregiver responsiveness did not emerge as a significant predictor in any of the regression models ($\beta s < .057$, $ps > .59$).

Discussion

The goal of the current study was to examine the longitudinal relations between caregiver responsiveness (i.e., the extent to which caregivers respond contingently, appropriately, and promptly to their infant's signals; Bornstein, 2012) in infancy and joint attention skills during the toddler years among neurotypical children. Additionally, the current study set out to investigate whether or not early social-cognitive behaviors emerging in infancy predict joint attention skills in toddlerhood. It was hypothesized that variability in caregiver responsiveness in infancy would longitudinally predict joint attention in toddlerhood such that caregivers who were more responsive to infants' focus of attention at Time 1 would have children who went on to have better joint attention skills as toddlers at Time 2. We also predicted that infants who showed higher levels of social-cognitive behaviors at Time 1, such as social attention towards a caregiver during play, triadic engagement, and communicative vocalizations, would be more jointly engaged as toddlers at Time 2. Results supported our second hypothesis only. Specifically, results showed that early social-cognitive behaviors demonstrated in infancy predicted toddler joint engagement. However, we found no evidence to suggest that caregiver behavior in infancy predicted joint engagement in the toddler years.

Our finding that a child's social-cognitive behaviors during infancy (i.e., face looks, triadic engagement, vocalizations) longitudinally predicted later joint engagement in toddlerhood is consistent with prior research. For example, Mundy et al. (2007) set out to examine individual differences in joint attention behaviors and the extent to which these individual differences were stable across time (from 9 to 18 months). Mundy and colleagues found that individual differences in responding to joint attention behaviors such as following gaze and gestures, and initiating joint attention behaviors such as using eye contact to establish social connection within an interaction, were relatively stable across the child's development. In other words, developmental continuity existed in that infants who engaged in more early joint attention behaviors at 9 months went on to engage in more joint attention behaviors at 18 months. The current findings expand upon this research, as it was found that this continuity extends into the early toddler years (i.e., 24 months olds). We also found that the strongest longitudinal patterns observed were amongst the more tightly related constructs: face looks and coordinated joint engagement (CJE) and vocalizations and symbol-infused joint engagement (SJE). This tells us that infants who engage in more social-cognitive behaviors go on to develop and use more advanced joint engagement skills as toddlers.

In addition to the longitudinal pathways that were supported in the current study, it is also important to acknowledge the pathway that failed to reach significance. Specifically, contrary to our hypotheses, caregiver

responsiveness in infancy failed to predict later joint engagement skills in toddlerhood. This finding was surprising given that previous studies have established relations between caregiver behaviors and joint engagement skills (e.g., Fadda & Lucarelli, 2017; Gaffan et al., 2010; Vaughn et al., 2003). For example, when investigating the relationships between caregiver behavior and child joint attention, Fadda & Lucarelli (2017) found that caregivers who participated in higher quality interactions with their infants had children who illustrated better joint engagement with another social partner. Additionally, both Gaffan et al (2010) and Vaughn et al. (2003) examined how caregiver responsiveness and scaffolding during an infant's early months predicted their joint attention a few months later. Both groups of researchers found that caregiver responsiveness at Time 1 (age 6 and 9 months, respectively) was significantly associated with joint attention skills at Time 2 (age 9 and 12 months, respectively). Each of these studies suggested that caregiver behavior likely plays a role in the development of joint attention in infancy, as well as the expression of its skills longitudinally. Thus, it is important to consider why the current findings were inconsistent with this previous research.

One potential explanation for our failure to find longitudinal relations between caregiver responsiveness during infancy and joint engagement in the toddler years has to do with how caregiver behavior was measured in the current study. When coding for caregiver responsiveness, our coding scheme focused on how often caregivers maintained versus redirected

infants' focus of attention. By doing so, we believed that we were capturing

the caregivers' ability to support and encourage their child's joint attention.

However, choosing to code in this way is different from traditional measures

of responsiveness, as well as caregiver behavior measures in previous

literature. For example, when coding for caregiver responsiveness,

Bornstein and colleagues (2008) considered the way in which caregivers

responded to their child's actions outside of simply maintaining or

redirecting their infants' focus of attention. That is, they considered

whether or not the mother was using affirmations to encourage the child's

actions, imitating/expanding upon what the child was saying, etc. By doing

so, researchers were able to determine variability within mothers'

responsiveness as well as follow the developmental trajectories of their

children. Additionally, researchers have considered how sensitive

caregivers are to what their child is doing throughout a play interaction,

how many times the caregiver showed an object, pointed an object out, or

demonstrated how an object works, and how actively the caregiver directs

their child's attention to a new object or event (Fadda & Lucarelli, 2017;

Vaughan et al., 2003). Therefore, future research should consider adopting

coding schemes that have been used in previous literature, while also

expanding the scheme so that it accounts for variations within caregiver

behavior (e.g., responsiveness *and* scaffolding *and* teaching behaviors). This

way, researchers can make more comprehensive conclusions as to what

specific caregiver behaviors influence the development of joint attention skills in their children, if at all.

Another potential reason why the current study may not have found significant longitudinal relations between early caregiver behavior and later joint engagement is that we may have measured caregiver behaviors too late. That is, by 8-to-12-months, infants are already showing meaningful variability in their joint attention abilities (Adamson et al. 2004; Adamson & Dimitrova, 2014; Morales et al., 2000; Tomasello & Carpenter, 2007), as seen by their performance on our measures of infant triadic engagement, communicative vocalizations, and face looks to caregivers. Thus it may be that individual differences in caregiver behavior even earlier in infancy are most critical. Our findings may be consistent with a mediation model where early caregiver behaviors predict early infant joint attention, which then predicts later toddler joint engagement. Indeed, because joint engagement begins emerging in infants as young as 4 to 6 months old (Adamson & Dimtrova, 2014), focusing on assessing caregiver behavior at this early point in infancy may help shed light on how caregiver behavior sets the stage for joint attention development. Therefore, future research should consider assessing caregiver behavior with an even younger sample in order to test this mediation model.

Conclusion

In conclusion, the current study provides new insight into the development of joint engagement during the toddler years. In particular,

our findings extend the existing literature on individual differences in joint

attention development by providing new evidence of longitudinal relations

between social-cognitive behaviors emerging in infancy (i.e., face looks,

triadic engagement, communicative vocalizations) and various forms of

joint engagement (i.e., coordinated joint engagement, symbol-infused joint

engagement) exhibited during the toddler years. However, our findings

provide no evidence of longitudinal relations between caregiver

responsiveness during infancy and joint engagement in the toddler years.

Additional research is needed to better understand how both individual-

level characteristics of the child and aspects of the caregiving environment

shape the development of joint attention from infancy to toddlerhood.

Appendix

Joint Engagement Rating Inventory (JERI)
Adapted from Lauren B. Adamson, Roger Bakeman, & Katharine Suma

Categories
Child Engagement State Items
22. Total joint engagement
3. Coordinated joint engagement
4. Symbol-infused joint engagement

Definitions
Child's Engagement State (Items 22, 3, and 4)
22. *Child's total joint engagement* describes the overall quantity of joint engagement during a scene. The low and high anchors are
> **No episodes of the joint engagement state**
> **Almost always in the joint engagement state.**

The midpoint of 4 characterizes a child who is in joint engagement for approximately half of the scene in several brief or a few relatively sustained episodes.

Joint engagement occurs when the child actively engages with the same object or event that the partner is attending to. Joint engagement may be as brief as a 3 second episode or it may be sustained for many minutes. Coding should be focused on how actively engaged a child is with the same object/event as their social partner.

There may be times when a child is seeking joint engagement but the partner is not
engaged with a shared object. There are also times when a caregiver is merely narrating
the child's actions ("background chatter") and not actively engaged in a shared activity.

3. *Child's coordinated joint engagement* describes both the quantity and the quality of the child's time in coordinated joint engagement. The low and high anchors are
> **No episodes of the coordinated joint engagement state and**

Frequently in rich and varied episodes of coordinated joint engagement.

The midpoint of 4 characterizes a child who spends about a third of the scene in coordinated joint engagement that is of moderate quality or a child who spends less time but the state is of strikingly high quality or more time but the state is of very low quality.

In coordinated joint engagement, the child and caregiver are actively involved with the same object or event and the child is actively and repeatedly acknowledging the caregiver's participation. Coding should reflect face looks/eye gaze & direct verbal engagement (i.e., specifically addressing the social partner; "mommy, your turn") from the toddler.

4. Child's symbol-infused joint engagement describes both the quantity and the quality of the child's time in symbol-infused joint engagement. The low and high anchors are

No episodes of the symbol-infused joint engagement state and
Frequently in rich and varied episodes of symbol-infused joint engagement.

The midpoint of 4 characterizes a child who spends about a third of the scene in symbol- infused joint engagement that is of moderate quality or a child who spends less time but the state is of strikingly high quality or more time but the state is of strikingly low quality.

In symbol-infused joint engagement, the child and caregiver are actively involved with the same object and event and the child is paying attention to symbols. Coding should reflect toddlers' gestures, using language (e.g., "I want that;" "hop, hop, hop;" "frog."), & responses to parents' directives.

Items and Their Anchors

Item	1 =	2 =	3 =	4 =	5 =	6 =	7 =
Total joint engagement *Child is actively engaging with the same object as social partner*	No episodes of the joint engagement state.	At least one brief period of joint engagement.	A child who spends less than half of the scene in joint engagement.	A child who is in joint engagement for approximately half of the scene.	A child spends more than half of the scene in the joint engagement state.	Almost always in the joint engagement state.	In the joint engagement state the whole time.
Coordinated joint engagement *Face looks/eye gaze & references to mom while in joint engagement.*	No face looks or references to mom in joint engagement.	1 face look or verbal reference to mom.	2 face looks or references to mom.	3 face looks or references to mom, or ~ 20 sec in CJE.	Spends about half of the scene in CJE with multiple (>3) indicators.	Spends more than half, but not all of the time, in CJE.	Almost always in CJE.
Symbol-infused joint engagement *Gestures, using language, & responding to parents' verbal directives while in joint engagement.*	No gestures, use of language, or responding to verbal directives in joint engagement.	One gesture, use of language, or response to moms' verbal directive.	2-3 gestures, uses of language, or responses to moms' verbal directive.	4-5 gestures, uses of language, or responses to moms' verbal directive -- or at least 20 sec in SJE.	Spends about half of the scene in SJE with multiple (>5) indicators.	Spends more than half, but not all of the time, in SJE.	Almost always in SJE.

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