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The role of caregiver-reported emerging social attention in predicting duration of orienting and social communication

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The Role of Caregiver-Reported Emerging Social Attention in Predicting Duration of Orienting and Social Communication

by

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Dissertation

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Abstract

Early identification of atypical development could lead to opportunities for earlier intervention, ultimately improving developmental outcomes. Early signs of atypical attention, social attention, and social communication development emerge in infancy, yet age at diagnosis of neurodevelopmental difficulties does not typically occur until well after the first year of life. In order to achieve this goal of early identification, sensitive and accessible tools are needed to identify infants at risk for atypical development. This study examined whether caregivers could report on emerging social attention behaviors in the first days to weeks of life with a novel, experimental scale (PediaTrac SSIP). This investigation is part of a larger prospective, longitudinal investigation with a sample of 571 caregivers of infants (48% female) who were born either full term (N = 331; 49% female) or preterm (N = 240; 46% female). The findings revealed that caregiver report of social attention behaviors measured by SSIP at the newborn (NB) and 2-month period was a significant predictor of social, symbolic, and total communication, and duration of orienting at 6 months. Maternal education was significantly *negatively* correlated with all caregiver report measures, and it contributed to a significant amount of variance in all models, particularly in reported communication at 6 months. Reported emerging social attention at the NB period accounted for a significant amount of variance in symbolic communication (6%) and duration of orienting (12%) at 6 months. The findings suggest that caregivers are able to report on social attentional behaviors within the first 2 months of life that may be a key predictor of attentional and communication behaviors at 6 months. Gestational age did not contribute significantly to variance in outcome in any of the models. This further suggests that maternal education is a crucial factor in examining predictors of developmental outcomes. Findings from this study support further investigation of caregiver

report as a tool for understanding aspects of development, including social attention and communication, from the first days of life.

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Introduction to Social Cognition

Social cognition includes complex processes that involve understanding the self and others to make sense of the social world (Cattran et al., 2018). The development of social cognition is vital to social communication, the focus of this investigation, as well as the development of relationships and mental health (Mundy, 2018). The purported processes that underlie social cognition include multiple and integrated cognitive skills and systems (e.g., attention, perception, language), and as such, social cognition is used as an umbrella term to capture a wide variety of behaviors and processes. The ability to share perspective or point of view with another; make mental representations of another's thoughts, beliefs, and/or feelings; and perceive and understand nonverbal social signals from another, including social attention, affect expression, eye gaze, and tone of voice, are examples of these social cognitive processes (Mundy, 2018; Senju, 2013). Neuroscience investigations have revealed cortical and subcortical network involvement in the processing and performance of social cognition and its related behaviors (Cattran et al., 2018). However, when and how these processes develop and become integrated over the course of early life from infancy is still relatively unknown (Mundy, 2018; Yamaguchi et al., 2009).

Characterizing the course of infant cognitive development has long been of interest in empirical study. Piaget proposed a stage theory of cognitive development that states that cognitive skills develop in order, so early stages must be met before moving onto more complex cognitive processes (Piaget, 1936). From this perspective, the development of more complex cognitive processes, such as social cognition, are only possible if the earliest stages of cognitive development are mastered (Bishop, 2000). According to Piaget's theory (1936), by 18 months of age, toddlers begin to engage in symbolic, imaginative play, indicating that they are able to take the perspective of another and process complex social information.

In contrast to Piaget's theory, Vygotsky (1978) believed that a child's understanding of the social world precedes cognitive development. This theory assumes that children use language as an internal tool to self-regulate as well as an external tool for social interactions that are mediated by caregivers (Hwa-Froelich, 2015; Vygotsky, 1978). Social learning theory states that learning occurs within the context of social and cultural interactions (Hwa-Froelich, 2015). Bandura's (1978) social learning theory states that learning occurs through imitation of others, with the expectation that outcomes of their interactions will be similar to those they have imitated.

Another theory of social cognition is interaction theory (Gallagher, 2013). This theory states that social interaction is bidirectional so that the child can influence and is influenced by interactions with caregivers and that the quality of these interactions is what determines developmental outcomes (Hwa-Froelich, 2015). Because both internal factors like temperament and biology and external factors related to the environment play an important role in these interactions, development varies widely among individuals (Gallagher, 2013).

Cognitive and information processing, social learning, and interaction theories serve as foundations for understanding how social and social communication skills are learned. Information processing theory, among others that seek to understand the cognitive aspects of social behavior, give broad insight into the development and acquisition of skills such as social communication, but they do not necessarily address the wide person-to-person variability that exists in social communication development and outcomes (Hwa-Froelich, 2015). With that, these theories are applied from what is known about information processing in adulthood, as clear understanding of development of social cognition in infancy is not well understood.

Information processing theory states that the course of appraising information has three sequential stages: sensory memory, short-term or working memory, and long-term memory (Atkinson & Shiffrin, 1968). Information processing theory further states that individuals have the ability to process stimuli both top-down and bottom-up in the sensory register, meaning that an individual is able to perceive stimuli utilizing cognition and previous memories, as well as perceive stimuli utilizing the senses as it is processed (Atkinson & Shiffrin, 1968). In contrast to Atkinson and Shiffrin's more general information processing theory, social information processing theories purport that the processing of social stimuli occurs simultaneously, rather than sequentially and employs many cortical regions working in concert, forming stronger connectivity among regions the more that they are employed (Hebb, 1949).

Social cognition relies on the successful cortical integration of several cognitive processes (e.g., attention, perception, language) over development, and it is reinforced through bidirectional and dynamic interactions (Thelen, 2005). In fact, integration of these processes is a critical task of early social development in infancy and childhood. One of the most vital cognitive processes to the development of social cognition is attention (Mundy, 2018). To assess the emergence of early attentional development, including attention to social stimuli, clinicians directly assess or query caregivers about behaviors such as localizing to caregiver's voice or social smiling. Historically, tools have not been developed that attempt to examine these behaviors via caregiver report until at least three months of age (e.g., Infant Behavior Questionnaire; Gartstein & Rothbart, 2003), although caregivers may be capable of reliably reporting on these developmental behaviors via caregiver tools even earlier. The following section will review the literature regarding attention development in infancy and suggest a need for earlier measurement of emerging social attention behaviors purported to be vital in the development of a key social cognitive skill, social communication.

Attention

According to Colombo and Cheatham (2006), attention refers to processes that mediate perceptual selection. The development of attention is of substantial interest in developmental literature, as attentional processes are foundational to the development of social communication (Colombo, 2001). Neuroscience investigations elaborating key nodes and networks of the attentional system in adulthood have led to interest in understanding how these networks develop and integrate over infancy (Gao & Lin, 2012). The current investigation attempted to indirectly assess perceptual selection (i.e., infant's orientation and response to touch, voice, and eye contact) through caregiver report of the infant's social attention. That is, to whom does the child "attend to," operationalized as the infant being calmed or soothed by either touch, voice or making eye contact.

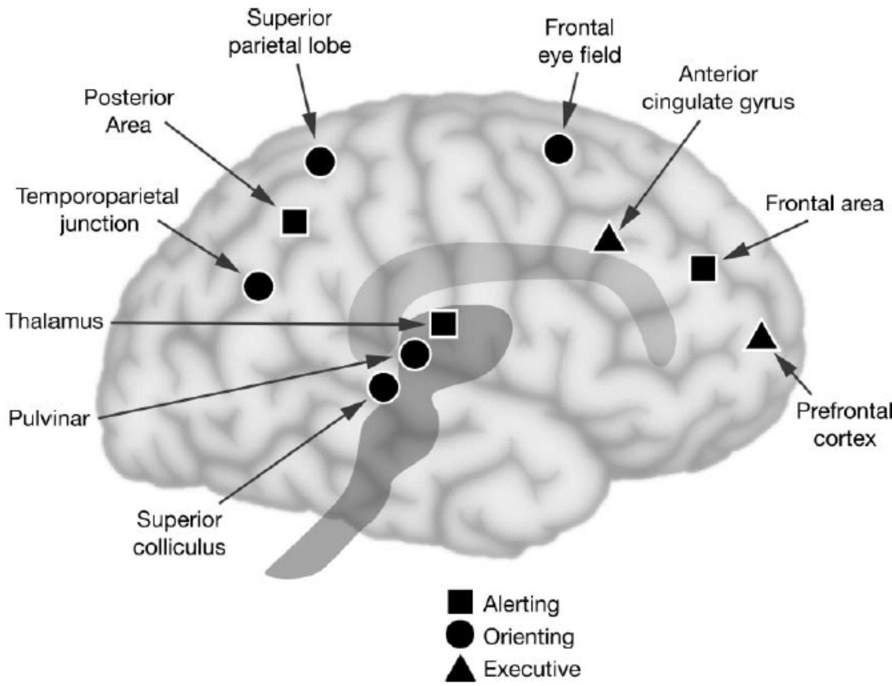
The following section will briefly review the major theory of attention relevant to this investigation (i.e. Posner & Petersen, 1990), with a focus on how attentional processes are purported to develop over the first year of life and across perceptual domains (i.e., visual and auditory). *Social visual* and *social auditory* attention are introduced within this section, although additional constructs of attention (selective, attention switching, sustained) typically investigated in child- and adulthood are also discussed for context. Joint attention will be reviewed within a social attention section, although it could easily be discussed within the domain of nonverbal social communication, as these processes are not mutually exclusive. Over development, joint attention supports the development of social communication. The proposed project assumes that joint attention is a subcomponent of social attention. Further sections will address gaps in attentional measurement and elaborate how assessment of social attention, specifically, is essential to understanding social communication, and describe how these processes are related in infancy.

Posner Model of Attention

Posner and Peterson's attention network theory (1990) divides attentional functioning into three distinct networks: alerting, orienting, and executive (see Figure 1). The alerting network is present from infancy and allows for maintenance of an alert state; the orienting network is involved in directing attention to sensory stimuli; and the executive network involves voluntary control of attention (Posner & Rothbart, 1998). The first two of these three networks are most relevant for the proposed investigation both with respect to their development in infancy and the proposed aims of the investigation and are reviewed below.

Figure 1

Brain Regions Involved in Each Network of Posner's Model of Attention



Note. Brain regions involved in each network of Posner's model of attention. From "Research on Attention Networks as a Model for the Integration of Psychological Science," by M.I. Posner and M. K. Rothbart, 2007, *Annual Review of Psychology, 58*(1), p. 6 (10.1146/annurev.psych.58.110405.085516). Copyright 2007 by Annual Reviews.

Alerting

The ability to remain alert is not possible until 30-weeks gestation and remains intermittent during the newborn period (Crade & Lovett, 1988). During the first 2 to 3 months of infancy, alert states are governed by external events and processes rather than volitional (e.g., response to caregivers in the environment). Over the first 3 months of life, subcortical pathways are maturing and exerting more influence over and coordination with cortical regions that help mediate these processes (Karmel et al., 1991). Brainstem regions like the reticular activating system and locus coeruleus have been implicated in maintaining an alert state and readiness for stimuli (Colombo, 2001). By 3 months of age, infant periods of alertness are lengthened, more distinct, and are more synchronous with the dark-light cycle (Berg, 1979; VandenBerg, 2007). Pathways ascending from subcortical to cortical regions in the brain are responsible for maintaining states of alertness (Colombo, 2001). For example, tactile or vestibular stimulation, like rocking or holding the infant, can induce visual alertness in newborn infants (Becker et al., 1993). Visual responses can be affected by manipulations of arousal or stimulation by other sensory modalities (Gardner et al., 1986). Early state organization is related to later cognitive functioning in the infant and can be related to systemic risk later in development (Colombo et al., 1989; Colombo & Horowitz, 1989; Moss et al., 1988). For this reason and as noted above, the current study aimed to examine infant attention by examining the reported frequency with which the infant directs visual attention and by whom can the infant be calmed using touch, holding, and voice.

Orienting

According to Cohen (1972), infant visual attention involves attention-getting and attention-holding processes. The attention-getting response, or orienting, is present, as stated from early in infancy, while sustained attention, or attention-holding develops later in infancy (Cuevas & Bell, 2014). The ability of an infant to efficiently focus attention undergoes changes from 3 to 6 months of age, with the development of the ability to orient and disengage voluntarily (Harman et al., 1994). Duration of orienting to stimuli increases over time, though prolonged orienting in infancy can suggest an inability to shift attention away from a particular stimulus (Colombo, 2001). Gartstein and Rothbart (2003) found that duration of orienting follows a U-shaped function such that duration of orienting is longer before and after 6 months of age. At 6 months, when joint attention is emerging, duration of orienting is shorter. Colombo and colleagues (2010) found that infant looking time is related to higher level cognitive processes like language and memory. They noted that longer looking time is actually associated with inefficient shifting of attention, while shorter looking times were related to more efficient and global processing of stimuli. Slow disengagement from visual stimuli at 14 months of age has been associated with later autism spectrum disorder (ASD) diagnosis (Elsabbagh et al., 2012). Inability to efficiently shift visual attention has been linked to problems with self-regulation as well as diminished attention to socially relevant stimuli at 3-4 years of age (Dawson et al., 2004).

Before 6 months of age and after 12 months of age, infants focus their attention on the eyes of caregivers, while at 6 to 12 months of age, as language is developing, infants shift their focus to the mouth of the caregiver (Posner et al., 2014). Disrupted visual attention to social stimuli (i.e., the caregiver's face) at 6 months of age has been associated with diminished emerging social communication ability, such as response to joint attention (RJA) or coordinated attention with a social partner (Bhat et al., 2010). According to Colombo (2001), individual differences in the development of attentional processes over the first year of life can make assessment of overall attentional abilities in infancy challenging. In infancy, there is a lack of coordination between involuntary functions mediated by subcortical structures and the higher-level, voluntary processes mediated by cortical structures. In this investigation, "social visual attention" will be measured in early infancy via caregiver report of eye contact.

Posner and colleagues (1994) described attentional development as progressing in a posterior-anterior manner, with the posterior component of the system developing before the anterior portion and undergoing marked development between 2 and 8 months of age (Rothbart et al., 1992). An essential process of this posterior portion is the ability to orient to an object or event by shifting attention from an immediate focus, and this process is purportedly regulated by regions of the parietal cortex as well as regions in the midbrain and thalamus (Posner & Petersen, 1990). According to Posner and colleagues (2012), it is thought that in infancy, the orienting network is most active, as voluntary, executive processes have yet to develop. Brain imaging studies in infancy have identified some evidence of overlap between orienting and executive network functioning during cognitive tasks, though the longer-range connections required for effective and efficient executive functioning are not well developed and do not coordinate in infancy (Posner et al., 2012). However, as noted, there appears to be rapid development of the ability to orient and disengage more efficiently between 3 and 6 months of age (Harman et al., 1994).

Compared to studies of infant visual attention, there have been relatively fewer investigations of auditory attention development in infancy. Auditory attention to stimuli is driven by the salience of those stimuli (Gomes et al., 2000). Making selections about pertinent stimuli in the environment is critical to learning, like the acquisition of language (Ribeiro et al., 2011). The process of orienting to sounds can be measured in infancy by head turning, heart rate deceleration, and high amplitude sucking (DeCasper & Fifer, 1980; Gomes et al., 2000). The ability to orient to sounds is present from the first days of life and may even be present in fetuses late in gestation (Voegtline et al., 2013). Newborn infants have been observed to orient to a variety of sounds, both human voices and other sounds (Morrongiello & Clifton, 1984). The salience of the stimuli appears to be meaningful to early orienting to auditory stimuli, and newborns show a preference for their own mother's voice hours after birth (DeCasper & Spence, 1986; Fifer, 1987; Moon et al., 1993; Moon & Fifer, 2000). Newborn infants seek sensory stimulation from their caregiver (Purhonen et al., 2005). DeCasper and Fifer (1980) found that 3-

day old infants preferred their own mothers' voices to voices of other women. Consistent with *social visual attention*, *social auditory attention* (i.e., social auditory orienting) was also measured by caregiver report of the infant's attention and response (i.e., calming) to the voice of the primary caregiver.

Current Constructs of Attention

Definitions of attention vary across the literature, including names for specific aspects of attention. Among the more commonly measured forms of attention are selective attention, attention switching, and sustained attention (Manly et al., 2001; Petersen & Posner, 2012) though the construct of social attention is less well understood and defined. Current conceptualizations of the above-mentioned constructs have been shown to be regulated by overlapping neural circuits in the brain. The following sections will briefly review the main constructs of attention with a focus on how these are relevant to social attention in infancy. This will be followed by a section exploring the unique quality of social attention.

Selective Attention

By the time humans reach adulthood, they are skilled at identifying which stimuli in the environment are the most important and are able to attend to those things while ignoring everything else (Bahrick, 2010). Selective attention can be defined as a purposeful allocation of resources to behaviorally relevant stimuli (Mesulam et al., 2001), including touch, voice, and eye gaze. Selective attention begins to develop in infancy and continues to become more efficient and sophisticated over development as the infant is able to more voluntarily attend to stimuli in the environment, for example, attending to a caregiver. The brain regions involved in this process include the superior parietal lobule, lateral premotor cortex, and anterior cingulate

(Booth et al., 2003). Selective attention is an important first step to information processing that leads to learning and memory (Bahrick, 2010), including social learning.

Investigations into early auditory attention selection have found that infants have the ability to selectively attend to even subtle deviations in speech sounds. Similar to early organization for affect recognition, it has also been suggested that infant brains are organized by 3 months of age to process emotional valence of human voices (Blasi et al., 2011). Response to name is a critical social milestone that develops over the first year of life (Miller et al., 2017). By 4 to 6 months of age, typically developing infants listen longer to their own names than to other names (Imafuku et al., 2014; Mandel et al., 1995). Hearing one's own name is a social cue that results in orienting to socially salient aspects of the environment, contingent on recognizing one's own name as relevant (Parise et al., 2010). Miller and colleagues (2017) found that infants who lacked response to name at 9 months of age were more likely to receive an ASD diagnosis in toddlerhood. These findings suggest that early attention to salient social, auditory stimuli is important for healthy social communication development.

Attention Switching

Successful cognitive development not only requires the ability to select which stimuli to attend to, it also requires the ability to switch attention to stimuli as importance and relevance changes (Hanania & Smith, 2010). Attentional shifting involves shifting one's focus from one mental set to another (Manly et al., 2001). The neural circuit involved in attentional shifting includes the parietal lobes, dorsolateral prefrontal cortex, and frontal eye fields (Snyder & Chatterjee, 2006).

Sustained Attention

Sustained attention or vigilance refers to the ability to direct attention to one or more sources of information for a period of time (Oken et al., 2006). Ability to sustain attention to a stimulus rapidly develops over the first few years of life, and individual differences in ability to sustain attention are present from infancy (Colombo, 2001; Johansson et al., 2015). Vigilance, or maintained looking time, has not been established in infants younger than five months of age (Colombo & Cheatham, 2006).

Social Attention

As noted, orienting of attention begins in infancy, and key questions in the developmental literature are whether special attention is paid to social stimuli, whether the processes involved in attention to social stimuli are unique and separate from processes involved in attention to non-social stimuli, and when and how these processes develop. A lack of systematic, longitudinal study of social attention development in infancy has led to a lack of clarity regarding the specific definition and operationalization of the construct (Salley & Colombo, 2016).

Social attention has variable definitions across the literature, but broadly includes joint attention, eye gaze processing, vocalization, and use of gestures with a social partner (Frank et al., 2014; Wellman et al., 2004). Generally, social attention studies investigate attentional preference toward social stimuli (e.g., faces, voices) as well as those assessing joint attention; that is, sharing and coordinating attention to a stimulus with another (Perra & Gattis, 2010). The concept of social attention and attempts to clearly operationalize it have become more prominent over the last decade. Salley and Columbo (2016) proposed that social communication behaviors, visual attention to social stimuli, and preference/reward for social stimuli are closely related, but separate constructs that converge into a unitary construct, social attention, over the course of typical development.

Joint Attention

Joint attention, in particular, has been used synonymously with social attention, based on Mundy and colleagues' (2007) definition of joint attention as the capacity for coordination of social attention (Salley & Colombo, 2016). Joint attention refers to the ability to coordinate attention with a social partner, like looking at the same object, to share a common perceptual experience (Mundy & Newell, 2007). The ability to engage in this process begins in the first nine months of life (Mundy et al., 2010). Mundy's model of joint attention (2010) proposes that joint attention involves integration of self-referenced information (i.e., information about the physiological state of the body and the physical actions of the body), information about the other person's attention, and information about the common object or event that is shared. This process and continued practice with engaging in joint attention engages frontal, temporal, and parietal cortices, and over time, this network serves a social-executive function that facilitates efficient and smooth coordination of attention to external events and objects in social interactions (Mundy et al., 2010). According to Mundy and colleagues (2010), the ability to engage in joint attention lays the groundwork for the later emergence of symbolic thought and social cognition.

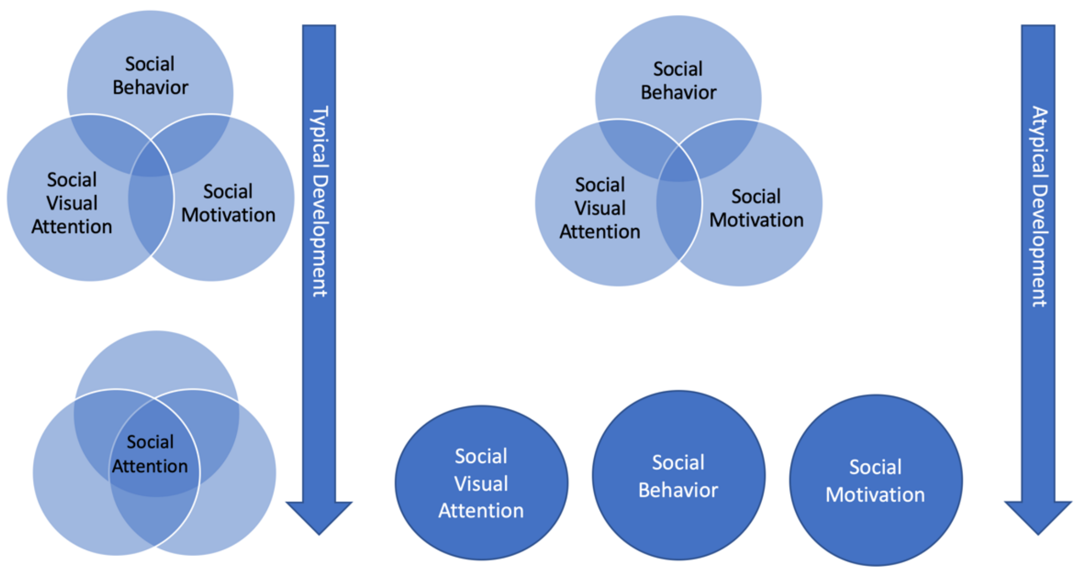
According to the parallel and distributed processing model (PDPM), joint attention can be divided into two independent but parallel networks: response to joint attention (RJA) and initiation of joint attention (IJA; Mundy et al., 2010). RJA refers to the ability to follow a social partner's directed gaze, gesture, or movement of the head toward a particular object or event, whereas IJA refers to the ability to use eye contact and gestures (i.e., pointing or showing) to establish shared attention with a social partner on a particular object or event (Mundy et al., 1992). RJA emerges first at about 6 months of age, while IJA develops between 8 and 10 months of age (Mundy et al., 2010). Though the earliest markers of joint attention emerge at 6 months of age, behaviors that are foundational to joint attention, like eye gaze, begin to develop from birth (Farroni et al., 2004). The current study aimed to identify whether there are pertinent and measurable social attention behaviors that emerge before RJA develops that could be predictive of difficulties with social communication development at 6 months, when RJA is purported to develop.

In ASD, early failure to orient to social stimuli is theorized as contributing to social communication deficits later in childhood (Dawson et al., 1998; Dawson et al., 2004; Mundy & Neal, 2001). Children with ASD have been observed to exhibit decreased response to their own name and diminished joint attention skills compared to same-aged peers (Osterling et al., 2002). The mechanism underlying visual social attentional deficits in children with ASD remain unclear (Dawson et al., 2004). Specifically, the question remains whether these deficits are due to attentional problems generally or whether there is a specific problem with attention to social stimuli (Salley & Columbo, 2016). It will be important to systematically examine social cognitive processes against more general cognitive processes to determine whether social attention is its own, independent operation separate from attention to non-social stimuli (Bedford et al., 2014).

Salley and Columbo (2016) proposed a model for typical versus atypical social attention development (see Figure 2). As stated, they suggested that social motivation, social behaviors (e.g., eye gaze, gestures, response to caregiver), and social visual attention begin as separate but closely related constructs and skills that converge to develop as an integrated yet differentiated social attentional construct. It is likely that these processes, similar to joint attention, are differentiating later in the mid to end of first year of life (Jones et al., 2018). Salley and Colombo (2016) further proposed that in atypical development, these processes do not integrate and become further fragmented and poorly coordinated. Currently, there are no models that hypothesize how both social visual and social auditory attention contribute to the development of a more global social attentional construct.

Figure 2

Model of the Development of Social Attention



Note. This model was produced by Salley and Colombo in 2016, depicting a proposed model for the development of social attention. From "Conceptualizing Social Attention in Developmental Research," by B. Salley and J. Colombo, 2016, *Social Development, 25*(4), p. 696 (https://doi.org/10.1111/sode.12174). Copyright 2015 by John Wiley & Sons Ltd.

A further barrier to understanding when and how these processes develop, integrate, and differentiate is a lack of systematic study of social versus non-social attentional behaviors. There is also a lack of systematic, longitudinal study of both typically developing and at-risk infants to further characterize the development of social attention. To add to the existing literature, this study attempted to measure the emergence of early social attention behaviors during the first weeks of life via caregiver report. Additionally, it also examined how these early behaviors predict caregiver-reported social communication and duration of orienting at 6 months of age.

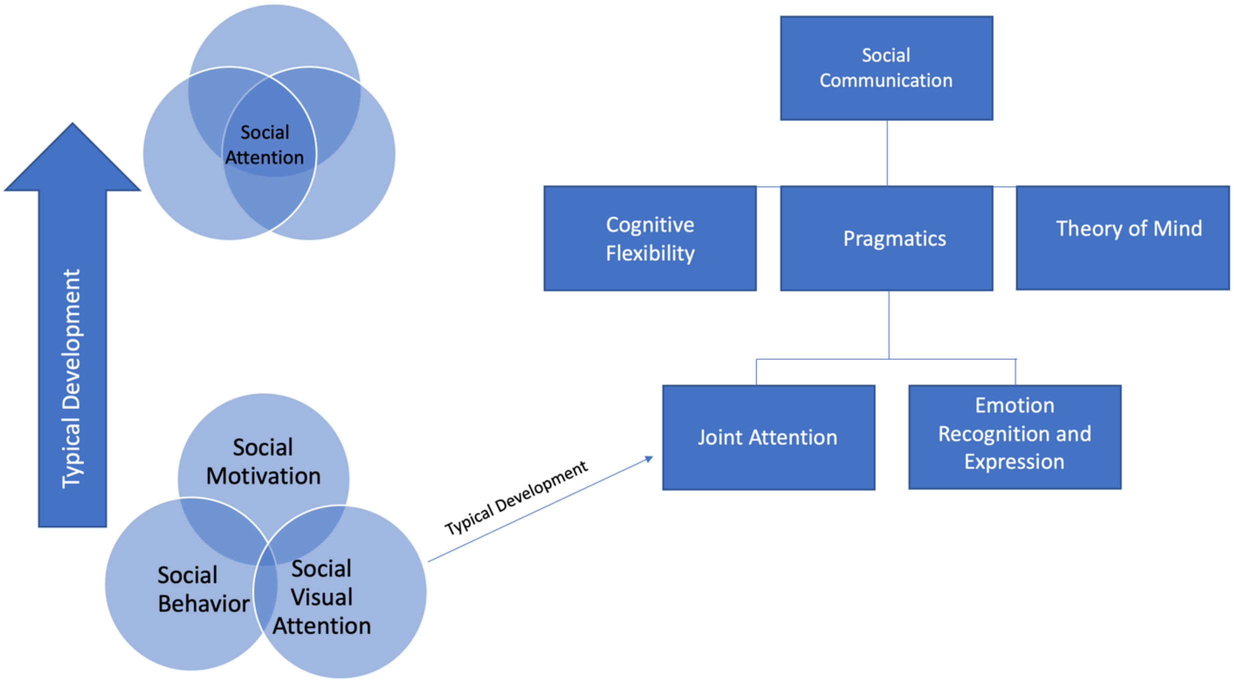
In sum, development of social communication, the focus of this investigation, requires the integration of interrelated cognitive processes, particularly social attention. Social communication begins to develop in infancy (Bedford et al., 2012), suggesting that this integration and coordination occur over the first year of life. However, limited is known about how and when these processes develop, and in turn, even less is known about which behaviors in infancy may be indicative of the need for early social or social communicative intervention. The following section will review the literature with regard to social communication development, and more specifically, nonverbal social communication development over the first year of life.

Nonverbal Social Communication

As noted, social communication begins to develop in infancy (Bedford et al., 2012). Even before the development of language, infants display nonverbal social communication behaviors that facilitate language acquisition and that subsequently enhance the quality of social interactions (Markus et al., 2000). For example, use of a facial expression or tone of voice in combination with language can indicate humor or sarcasm that may not be detected from the words alone. Nonverbal social communication behaviors begin to develop in the first weeks of life, and their development is critical to future social, emotional, and psychological success (Vernetti et al., 2018). Behaviors such as eye gaze (Corkum & Moore, 1998; D'Entremont, 2000; Grossmann et al., 2013), affect recognition and expression (Hoehl et al., 2008), use of gestures (Swain et al., 2015), and joint attention (Carpenter et al., 1998; Corkum & Moore, 1998; Mundy et al., 2010; Mundy & Jarrold, 2010; Mundy & Newell, 2007) all develop before language in the first year of life. Wiseman-Hakes and colleagues (2020) proposed a multifaceted model for understanding social communication that includes several cognitive functions (see Figure 3). In this model, those processes depicted in the lowest tier are relevant to the current study as the they support and build upon the more complex forms of social communication processes reflected in the middle tier. Essential nonverbal social communication behaviors that begin to develop in infancy, including gaze processing, affect recognition and expression, and gestures will be reviewed in the following sections.

Figure 3

Model Linking Social Attention and Social Communication Development



Note. This model demonstrates the link between social attention and social communication development by combining two separate models to draw a conceptual link between the constructs, particularly highlighting how social visual attention in infancy over the course of typical development develops into joint attention behaviors, which are foundational to social communication. From "Conceptualizing Social Attention in Developmental Research," by B. Salley and J. Colombo, 2016, *Social Development, 25*(4), p. 696 (https://doi.org/10.1111/sode.12174). Copyright 2015 by John Wiley & Sons Ltd. And from "A Conceptual Framework of Social Communication: Clinical Applications to Pediatric Traumatic Brain Injury," By C. Wiseman-Hakes, L. Kakonge, M. Doherty, and M. Beauchamp, 2020, *Seminars in Speech and* Language, *41*(2), p. 147 (https://doi.org/10.1055/s-0040-1701683). Copyright 2020 by Thieme Medical Publishers, Inc.

Gaze Processing

Eye gaze is a cornerstone of social communication that can provide a window into another's thoughts, feelings, and attitudes toward a social partner, and the purpose of a social interaction (Kleinke, 1986). Even in the first few weeks of life, infants are more highly attuned to faces than other stimuli in their environment (Farroni et al., 2002). Starting in infancy, humans use gaze to guide social interactions (Beier & Spelke, 2012). In fact, Farroni and colleagues (2004) found that infants were able to discriminate between direct and averted gaze of a schematic face within the first day of life. Attention to gaze is purported to develop very early in infancy, and for neurotypical individuals, gaze following in response to averted gaze is reflexive (Haxby et al., 2002; Nation & Penny, 2008). Eye gaze is a precursor to the development of the ability to infer the mental state of others (i.e., theory of mind), a critical social behavior (Nation & Penny, 2008). Since eye gaze is an early, foundational skill for social development, it could be of particular interest with regard to identifying risk for later atypical social development (Bedford et al., 2012; Elsabbagh et al., 2012; Merin et al., 2007).

The exact developmental course of eye gaze processing remains unclear (Senju et al., 2008). Eye gaze can be directly measured by experimental methods such as looking time or with tools such as eye tracking in the first months of life (Falck-Ytter et al., 2013; Tomalski & Malinowska-Korczak, 2020). However, caregiver report measures targeted to assess nonverbal social communicative behaviors including eye gaze processing (i.e., Communication and Symbolic Behavior Scales- Developmental Profile (CSBS-DP)) do not begin to assess eye gaze until 6 months of age (Wetherby & Prizant, 2002). The current study aimed to measure this social process within the first few months of life via caregiver report.

Emotion Expression and Recognition

The study of emotional expression in infants is faced with methodological challenges. Infants do not have the ability to explain what they want or need verbally, and objective examination of facial expressions, particularly during crying, can make it difficult to isolate any one emotion, like frustration from hunger or sadness (Messinger, 2002). With regard to positive affect, infant social smiling occurs around 2 months of age, accompanied by the infant's enhanced awareness of others in the environment and increased orienting to faces, as well as eye contact (Wörmann et al., 2012).

The recognition of another's emotional state is another essential part of social communication. It appears as though certain emotions are ubiquitous and cross-cultural (Ekman & Friesen, 1986), and the recognition of these emotions expressed by a social partner is critical to form emotional connections (Hiatt & Campos, 1979). Ekman et al. (1972) identified happiness, surprise, fear, sadness, anger, and disgust as universal emotions. In infancy as opposed to studies with older individuals, it is not possible to engage infants in matching tasks (i.e. matching a facial expression with a particular emotion), rather, studies rely on infants' ability to differentiate emotions (McClure, 2000). This is typically best understood by studies that examine visual preference for a particular facial expression by length of gaze at each stimulus (Barrerra & Mauer, 1981). Infant ability to discriminate facial expressions is present by three months of age, and even newborn infants are able to discriminate some aspects of facial expressions, like mouth open versus mouth closed, suggesting that infants may be born biologically prepared for processing facial expressions (Leppänen & Nelson, 2006). By 12 months of age, infants are thought to have developed more complex affect recognition skills that facilitate social referencing (McClure, 2000). They appear to be able to make inferences about particular situations based on the affect expression of another. For example, Sorce and colleagues (1985) discovered that infants in a visual cliff study were unwilling to pass the visual cliff if their mother displayed a fearful facial expression compared to about three quarters of infants who passed the visual cliff when their mother exhibited a happy expression.

Prior investigations have also examined the ability of infants to attend to and recognize other forms of emotional expression, such as the intonation and inflection of voice (Mehler et al., 1978). Infants are also able to identity prosodic changes in voice that are indicative of emotion expression in the first months of life (Grossmann, 2010). As early as four months of age, infants recognize their mother's voice faster than unfamiliar voices (Purhonen et al., 2005), and neural circuits that underlie the mother's voice perception have been shown to predict social communication in childhood (Abrams et al., 2016). An infant's ability to be soothed by a caregiver's voice is indicative of early social responsiveness and affect regulation (Gartstein & Rothbart, 2003). The current study also aimed to examine how infants' respond to emotional expressions of soothability via caregiver report, including if they can discriminately be calmed by the voice or touch of the primary caregiver.

Gestures

Gestures are a nonverbal form of expression or communication using physical movements of the body (Salo et al., 2018). Like language, gestures are symbolic such that a gesture can be used to refer to an object or action (Acredolo & Goodwyn, 2009). For example, an infant might put their arms up, indicating that they wish to be picked up. Gestures are an important aspect of social communication, as they can add meaning to vocalization. For example, an infant crying and raising her arms to be held is able to communicate a wish to be held before having the words to do so. Integration of gestures with crying gives the caregiver greater insight into the needs and wishes of the infant, making it more likely that their needs will be met. The first gestures, like clapping and rhythmic hand banging, tend to emerge at 6 to 8 months as babbling develops while gestures that indicate giving, showing, pointing, and routine gestures like waving goodbye develop between 8 and 10 months of age (Bates & Dick, 2002). Routine gestures are culturally determined and vary greatly (Iverson et al., 2018). The current study assessed gesture by caregiver report with the CSBS-DP at six months of age to examine relationships between the earlier described emerging social attention with later emerging gestures at 6 months of age.

The previous sections have outlined and characterized what is known about attention and social communication across early development. Insights into typical development are important to provide context for early signs of atypical development. As clinical practice aims to provide opportunities for early intervention for children at risk for problems with social attention and social communication, early monitoring and assessment of those at highest risk is vital (Monteiro et al., 2016).

Atypical Attention and Social Communication Development

Infants born preterm and low birth weight are at risk for neurodevelopmental problems including social communication disorders such as ASD, cognitive impairment, and social-emotional problems (Arpino et al., 2010). Over the last two decades, incidence of preterm and low birth weight infants has increased, in part due to the use of fertility treatments that have led to higher rates of multiple births (Kulkarni et al., 2017). In a study that longitudinally followed very low birth weight infants, incidence of a later ASD diagnosis was nearly four times the rate in the general population (i.e., 1 in 21 versus 1 in 88; Mohammed et al., 2016). Perinatal risk factors like preterm birth, low birth weight, and small for gestational age have been linked with higher incidence of intellectual disability and ASD (Schieve et al., 2015). Another investigation into perinatal risk factors also found that preterm birth and low birth weight status were related to later onset of ASD (Lampi et al., 2012). In a longitudinal study that followed infants born term and preterm at 6 and 18 months (age corrected for the preterm infants), researchers found that preterm infants had poorer performance on the personal-social domain of the Griffiths Developmental Scales (Forcada-Guex et al., 2006).

Infants born preterm show altered development of alerting, orienting, and executive attention (van de Weijer-Bergsma et al., 2008). Weijer-Bergsma and colleagues (2008) stress the importance of considering that while individual attentional processes may be intact in preterm infants, the integration and coordination of these processes may be impaired over the course of development. Preterm birth is also associated with atypical social orienting, as measured by eye tracking (Telford et al., 2016). It is unclear exactly why infants born preterm are at risk for diminished attentional functioning in childhood, though it could be possible that deficits in early attentional abilities could lead to fewer opportunities to learn (Murray et al., 2016).

There are several potential causes of atypical social communication development in infants born preterm. First, infants born preterm, and specifically those born very preterm are at very high risk for suffering acquired brain injuries (Fenoglio et al., 2017). Despite high rates of brain injury, even when controlling for brain injury in this population, there is increased risk for nonverbal social communication deficits (Johnson et al., 2010). A potential explanation could be that birth before 40 weeks and the resultant ex-utero exposure disrupts typical neural network development (Cao et al., 2017).

Measuring the earliest emergence of social communicative skills via caregiver report may serve as a novel and highly accessible method of identifying infants at risk for social communication disorders such as ASD. Recent research has shown that children with a biological sibling with ASD who were later diagnosed showed limited use of gestures, reduced imitation, atypical eye contact, and less pointing within the first 12 months of life (Bryson et al., 2007; Macari et al., 2012; Rozga et al., 2011; Soto et al., 2016). In fact, early markers of risk for atypical social communication development may emerge as early as 2 months of age (Jones & Klin, 2013). Despite early signs of atypical social communication development, diagnosis of disorders, including neurodevelopmental disorders like ASD, often occurs much later in childhood, between ages 3 and 5 years, potentially missing a critical period for intervention (Baio et al., 2018). There are a number of behavioral deficits detected in childhood that could be identified earlier with a better understanding of the developmental course of these behaviors. For example, difficulty processing faces, including discriminating between familiar and unfamiliar faces is present in children with ASD, and little is known about whether this deficit begins to emerge in infancy (Key & Stone, 2012). Infancy could serve as a period for caregiver-reported identification of early signs of atypical social communication, resulting in opportunities for early, intensive intervention that could ultimately lead to better outcomes.

Infants at high risk for ASD, as defined by having a biological sibling with ASD, are also less likely to attend to both auditory and visual social stimuli and engage in less social referencing with significant others in their environment (Cornew et al., 2012). In ASD, atypicalities in attentional abilities have been identified with regard to alerting, orienting, and executive attentional systems (Keehn et al., 2013). In fact, Keehn and colleagues (2013) stated that atypical attentional disengagement may cause cascading effects on social communication abilities, including joint attention and language acquisition, and that a goal of future research should be to examine attention network development in infants at risk for ASD.

In addition to more precisely operationalizing social attention and its relationship with social communication, it is important to develop reliable ways to assess social attention development from infancy. In this investigation, as noted, the earliest emergence of social attention is measured by caregiver report. More specifically, we have developed questions that query caregivers to tell how often their infant is responding to the primary caregiver via eye contact or as demonstrated by calming in response to the caregiver’s touch or voice. Valid and reliable assessment of these constructs during infancy may allow for a deeper understanding about the developmental course of social attention in typical and atypical development. The following section will review current methods of assessment of attention, social attention, and social communication, with a focus on measurement in infancy followed by the intended contribution of the proposed measurement methods.

Assessment of Social Communication and Attention

With increasing interest in identifying risk for atypical social development earlier, there is a need for assessment measures that accurately capture those at risk. Current assessment methods include few direct observations of behavior, usually carried out in a clinical setting (e.g., Bayley Scales of Infant Development, Mullen Scales of Early Learning; Anderson et al., 2010). This is a costly, resource intensive method of assessment, and there are several limitations to accessibility of these methods (Lajiness-O'Neill et al., 2018). As such, caregiver report measures have been developed to screen infants in a more cost-efficient way (Bethell et al., 2011). Clinically, direct and caregiver reports of behavior are used to determine possible areas of concern for development.

Direct Methods of Social Communication and Attention

In infancy, there are direct measures of development that are used to determine whether infants exhibit delays with regard to motor, language, and cognitive development (Luttikhuizen dos Santos et al., 2013). Direct measures of development are designed to be completed by a trained professional through observation of the infant completing tasks, typically in a healthcare setting (Morsan et al., 2018). The results of the assessment are then compared to a normative sample that includes healthy infants with no suspected medical or developmental problems (Hoskens et al., 2018). The current paper will examine several, not all, instruments that have relevance to this proposed investigation and the constructs of interest, attention and social communication, as there are no current assessments of social attention, specifically.

Attention

The most commonly used general developmental assessments do not include validated scales that measure attention development in infancy. For example, the Bayley Scales of Infant and Toddler Development, Fourth Edition (Bayley-4) and the Mullen Scales of Early Learning (MSEL), another direct measure of infant development, only assess attention development in infancy though specific items within scales on the Bayley-4 and MSEL measure attention, like visual attention, but there is a lack of focus on social attention (Bayley, 2006; Mullen, 1995). For example, both measures include an item that assesses whether the infant can track an object with their eyes, but there is not a specific measure of attention to social stimuli. According to Brito and colleagues (2018), there is lack of standardization across domains of development outside of those included in measures like the Bayley-4 and MSEL (e.g., expressive and receptive language, gross and fine motor skills), including attention development.

Social Communication

Measures of general development vary with regard to their attention to social communication. For example, the Bayley-4 is one of the most commonly used clinical assessments of early development, and social-emotional development is a domain included in the assessment, but only through caregiver report; there is no direct assessment of social-emotional behavior (Bayley, 2006). Rather, language in the traditional sense (i.e., receptive, expressive), motor skills, and cognition are assessed via direct observation, but social communication skills are not explicitly assessed. Similarly, the MSEL does not explicitly assess social communication development in infancy though social communication is embedded within the receptive and expressive language content (Mullen, 1995). That is, these measures include specific items that assess for some social communication behaviors, for example, response to name, but they do not separate social communication from language and cognition.

Taken together, direct measures in infancy can offer more in-depth assessment of a child’s development, but there are few direct measures that specifically assess social attention, particularly in infancy. As stated, there are also barriers to accessibility of direct assessment, like lack of qualified providers to administer them (Lajiness-O'Neill et al., 2018). Not every child is in need of in-depth developmental assessment, and as such, there is a need for sensitive screening measures to detect children who may be in need of close monitoring or early intervention (Pontoppidan et al., 2017). Caregiver report measures offer an efficient way to screen for developmental problems in infancy (Hix-Small et al., 2007). Because brief screens could determine need for further assessment, it is imperative that caregiver report measures are sensitive to developmental delays broadly as well as with regard to social communication development in order to ensure that those are risk are being identified as early as possible.

Caregiver Report Methods of Measuring Attention and Social Communication

Attention

Temperament is defined as biologically based individual differences in attention, motor response, emotion, and self-regulation to environmental stimuli across contexts (Bornstein et al., 2015; Rothbart et al., 2011). The emergence of self-regulation is an important part of infant temperament, as regulation of emotion and attention is critical to development, including social development (Planalp & Braungart-Rieker, 2015). According to Rothbart and colleagues (2011), reactivity and self-regulation are aspects of temperament that modulate the intensity and duration of orienting, emotional, and motor responses and underlie eventual effortful control and executive attention.

Standardized behavioral assessments of infant temperament have been developed to characterize foundational skills such as attention and duration of orienting. One such caregiver report of temperament is the Infant Behavior Questionnaire-Revised (IBQ-R; Gartstein & Rothbart, 2003). Research with the IBQ-R has identified three broad factors of infant temperament: surgency, or positive affect expression, negative affect expression, and orientation and regulation of attention (Garstein & Rothbart, 2003). The IBQ-R was designed to assess infant temperament via caregiver report for infants aged 3 to 12 months of age. The proposed study utilizes the IBQ-R so that relationships between the experimental constructs of social visual and social auditory attention assessed in the first days and weeks of life can be examined with the validated orientation and regulation of attention factor, as determined by factor analytic methods (Gartstein & Rothbart, 2003). The duration of orienting scale on the IBQ-R is comprised of the following subscales: Low Intensity Pleasure, Cuddliness, Duration of Orienting, Soothability, and Attentional Shifting load onto orienting and regulating (Garstein & Rothbart, 2003). Development of this scale on the IBQ-R has a theoretical basis in the underlying cognitive processes that are purported to come online during this stage of infancy.

Orienting is important for regulation of distress in infancy. Greater flexibility of orienting at 4 months is related to improved soothability (Johnson et al., 1991). Flexibility in orienting is important for early emotional control and is foundational to the development of self-regulation, including shifting attention from objects to caregivers. Posner and colleagues (2014) found significant correlations between the duration of orienting scale on the IBQ-R at 7 months and performance on an attention task at 7 years. The same study also indicated that caregiver reported duration of orienting at 7 months was related to better parent reported effortful control and soothability at 7 years (Posner et al., 2014). Toddler temperament predicts later childhood psychopathology, including mood dysregulation as well as attention deficit/hyperactivity disorder (ADHD), with significant concern for attention regulation in toddlerhood that persists into preschool age (Gaspardo et al., 2018; Keuler et al., 2011; Klein et al., 2015).

Social Communication

Though caregiver report measures have been developed for assessment of social communication behaviors in infancy, a limitation to some of these measures is that they may vary with regard to sensitivity in detecting more subtle delays (Johnson & Marlow, 2006). Because of this, we do not have a systematic way to chart social-behavioral growth over time in infancy using caregiver report beginning at the newborn period. Clinically, broad screens like the Ages and Stages Questionnaires (ASQ-3) are used to determine whether a caregiver reports that their infant is falling behind based on a cutoff score, and if so, that could lead to the infant having more thorough, direct assessment of development and/or social behavior (Squires & Bricker, 2009). The ASQ-3 assesses some social communication behaviors through "Communication," "Personal-Social," and "Problem Solving" domains from 1 to 66 months of age, but these scales combine questions about language, social communication behaviors, and early cognition (Squires & Bricker, 2009). Lack of clarity among and within these domains makes it difficult to assess specifically for social communication in infancy.

For some caregiver report measures, more specific social behaviors are not assessed until later into the first year of life (Briggs-Gowan & Carter, 2006; Robins et al., 2009; Wetherby & Prizant, 2001). This is likely due to the lack of clearly operationalized behaviors that could serve as the earliest markers of abnormal social communication development. Wetherby and Prizant (2001) developed the Communication and Symbolic Behavior Scales Developmental Profile (CSBS-DP) to include a caregiver checklist to screen for delays in early communication development, starting at six months of age. This measure has the benefit of offering standardized scores for each domain of communication, including social and symbolic (i.e., gestural) communication. Because use of this tool begins at 6 months of age, the earliest markers of development that could predict atypical social communication development are potentially missed.

The available instruments of caregiver-reported attention and/or social attention and social communication in infancy are limited. To date, there are no comprehensive screening tools that examine these constructs beginning in the newborn period for longitudinal measurement and tracking. As stated, there is a lack of understanding of social attention development, in part because the developmental course is unclear (Salley & Colombo, 2016). Currently, there are no clinical assessment tools for measuring social attention development in infancy.

To address the aforementioned gaps in the literature, the current study measured the earliest social communicative behaviors, social attention, via caregiver report and investigated the predictive ability of these behaviors in early infancy (newborn and 2 months) on attentional development and social communication at 6 months of age.

Current Study

PediaTrac is an experimental caregiver report measure for assessment of longitudinal, multidomain assessment of infant development (Lajiness-O'Neill et al., 2018; Lajiness-O'Neill et al., 2021). The current study specifically examined the response pattern of caregivers to the Social Sensory Information Processing (SSIP) questions, an experimental domain within PediaTrac to examine early social attention and responsiveness to caregivers, at the newborn and 2 month time periods as a potential measure of emerging social attention. More information about the SSIP questions is presented below in the methods section. The study examined whether the SSIP responses are predictive of attentional functioning and social communication at 6 months of age as measured via caregiver report using validated measures (IBQ-R SF and CSBS-DP). Six months of age was chosen as this is when key social communication behaviors emerge, including RJA. Finally, the study also attempted to determine whether social attention (SSIP) reported at the newborn and 2 month periods could predict both social and non-social attention and social communication at 6 months of age. The REG scale on the IBQ-R SF includes items that measure both social and non-social attention. The following section outlines the aims and hypotheses of the proposed investigation.

Aims and Hypotheses

The current study included a subset of infants participating in a large, multisite study, PediaTrac.

Aim 1

The first aim of the study was to examine relations between gestational age, emerging social attention at newborn and 2 months, and social communication and duration of orienting at 6 months. Relationships between predictor and outcome variables with covariates, infant sex and maternal education, were also examined.

Hypothesis 1

Emerging social attention at newborn and 2 months would be significantly positively correlated with social communication and duration of orienting at 6 months.

Aim 2

The second aim of the study was to examine whether gestational age and emerging social attention at newborn and 2 months would be significant predictors of social communication at 6 months.

Hypothesis 2

Gestational age and emerging social attention at newborn and 2 months would predict social, symbolic, and total communication at 6 months such that higher reported emerging social attention would predict higher reported social, symbolic, and total communication at 6 months. Given preterm birth as a known risk factor, it was hypothesized that lower gestational age would predict poorer social, symbolic, and total communication at 6 months.

Aim 3

The third aim of the study was to examine whether gestational age and emerging social attention at newborn and 2 months would be significant predictors of duration of orienting at 6 months.

Hypothesis 3

Gestational age and emerging social attention at newborn and 2 months would predict duration of orienting at 6 months such that higher reported emerging social attention would predict higher reported duration of orienting at 6 months. Given preterm birth as a known risk factor, it was hypothesized that lower gestational age would predict poorer duration of orienting at 6 months.

Methods

Participants

Participants in the study were caregivers of term and preterm infants who were followed longitudinally from newborn to 18 months of age (with a subset returning at 24 months of age that will undergo a neurodevelopmental assessment). Assessment periods were commensurate with well-child visits in infancy and include assessment at the newborn, 2-, 4-, 6-, 9-, 12-, 15-, and 18-month periods.

This investigation included a sample of 571 caregivers of infants (48% female) who were born either term (*N* = 331; 49% female) or preterm (*N* = 240; 46% female). Participant demographics are presented in Table 1 About 48% of the infants included in the sample were White. Approximately 33% of caregivers reported income below the national poverty threshold, and maternal education level ranged from some/completed high school (23%) to some/completed postgraduate or professional degree (25%). The sample consisted of participants from three academic medical centers and a community clinic; heretofore referred to with the following acronyms: Eastern Michigan University (EMU), University of Michigan (UM), and Case Western Reserve University/University Hospitals (UH; see Appendix A).

Table 1

Pooled Demographics and Characteristics of Infants and Caregivers

Infant Sex	
Male	298 (52.2%)
Female	273 (47.8%)
Term Status	
Full-term	331 (58.0%)
Pre-term	240 (42.0%)
Gestational Age at Birth	
Full-term	39.0 ± 1.15
Pre-term	33.0 ± 2.96
Infant Race*	
African American	192 (34.1%)
Multiracial	58 (10.3%)
Other	5 (0.89%)
White	272 (48.3%)
Ethnicity	
Hispanic/Latino	36 (6.39%)

Note. *Self-identified race categories White, Black/African American, Multiracial and Other are Non-Hispanic. Race was unknown for eight infants. Ninety-eight percent of caregivers were biological mothers. Marital status was missing for one caregiver. ADI = Area Deprivation Index. Gestational age at birth, maternal age, and household ADI are presented as mean ± standard deviation. Income was categorized relative to the US Department of Health and Human Services Poverty Guidelines (2019) and median household income for Michigan. This categorization is based on the number of people in the home as well as household income. The total number of cases differ, for example, from the total number of participants because of missing income information either from declining to state n = 46 or no response n = 10.

Table 1 Continued

Pooled Demographics and Characteristics of Infants and Caregivers

Caregiver Age at Enrollment (years)	30.1 ± 6.04
Household ADI	5.32 ± 3.33
Household Income	
Below poverty	169 (32.8%)
Below median	70 (13.6%)
At/above median	122 (23.7%)
At/above twice median	88 (17.1%)
Above $150,000	66 (12.8%)
Maternal Education	
Some/completed high school	133 (23.3%)
Some college or trade, technical, or vocational training	160 (28.0%)
College graduate	136 (23.8%)
Some/completed postgraduate or professional degree	142 (24.9%)
Caregiver Marital Status	
Married	305 (53.5%)
Not married	265 (46.5%)

Note. *Self-identified race categories White, Black/African American, Multiracial and Other are Non-Hispanic. Race was unknown for eight infants. Ninety-eight percent of caregivers were biological mothers. Marital status was missing for one caregiver. ADI = Area Deprivation Index. Gestational age at birth, maternal age, and household ADI are presented as mean ± standard deviation. Income was categorized relative to the US Department of Health and Human Services Poverty Guidelines (2019) and median household income for Michigan. This categorization is based on the number of people in the home as well as household income. The total number of cases differ, for example, from the total number of participants because of missing income information either from declining to state n = 46 or no response n = 10.

Group comparisons were conducted to examine differences across key participant variables across sites. With regard to site differences, EMU and UH did not differ in predictor or outcome variables, so they were combined into a single group (EMU/UH n = 339; UM n = 232). There were no infant sex differences between sites, $t(569) = 0.84$, $p = .40$, $d = 0.07$. There were significant differences between EMU/UH and UM on participant demographic variables. Specifically, maternal education was significantly higher in the UM (M = 5.22, SD = 1.71) compared to the EMU/UH group, with a large effect size (M = 3.52, SD = 1.71), $t(569) = -11.48$, $p < .001$, $d = -0.97$. Gestational age was significantly higher in the EMU/UH group than the UM group (M = 37.03, SD = 2.94), with a small effect size, (M = 35.71, SD = 4.36), $t(569) = 4.03$, $p < .001$, $d = 0.37$. Notably, the EMU sample consisted of primarily full-term infants.

Inclusion/Exclusion

All participants underwent an eligibility screening prior to enrollment. Participants were required to have consistent access to the internet via a personal device, such as a smartphone, tablet, or laptop to complete the PediaTrac modules. Additionally, measures were provided only in English, and as such, it was required that caregivers speak English in the home. Caregivers were required to be at least 18 years of age at the time of enrollment to participate. Infants were classified as term and preterm. Term infants were born at least 37 weeks gestation, had a minimum birth weight of 2,500 g, no history of prenatal or intrapartum complication, and no brain injury, neurological illnesses or disease (e.g., seizures), or known genetic disorders. Preterm infants were those born fewer than 37 weeks gestation. No infants with neonatal abstinence syndrome or Down Syndrome were eligible to participate in the study. If an infant was a multiple and each infant was eligible, random assignment was used for enrollment. All eligible caregivers were sent study materials for the newborn period when they reached the equivalent of 39 weeks gestational age.

Site Specific Recruitment

University of Michigan Recruitment

At UM, full-term dyads were recruited from the Women's Mental Health Registry (OB Registry), Department of Psychiatry. The OB Registry targets the female population seeking prenatal care within UM. The Registry identified women who were eligible for and interested in participation in this research project and distributed copies of consent forms or informational flyers (with sections specifying that they can be contacted and how) describing studies to patients during select OB visits (first or third trimester or both depending on the clinic). Initial contact with the caregiver was made once the caregiver reached 34 weeks post-conceptional age to determine whether the caregiver was interested in participating. Once the infant was born, eligibility screening was completed with interested caregivers.

Recruitment for preterm infants from the Division of Neonatal-Perinatal Medicine at UM occurred in the NICU; families were approached when their infant reached at least 34 weeks post-conceptional age (as determined by a physician) to share information about the study. An informational flyer was provided (with sections specifying that the caregivers can be contacted and how that would happen) to parents of babies admitted to the NICU. If caregivers were interested in participating and met inclusion criteria, the caregiver's information was provided to the UM PediaTrac Study team to be contacted. If an infant remained admitted to the NICU, caregivers were met in person to discuss the study, and eligibility screening and enrollment was completed in the hospital.

Case Western Reserve University/University Hospital Recruitment

At UH, full-term dyads were recruited from the maternity units at University Hospital's McDonald Hospital for Women (MacDonald House/Newborn Nursery), as well as the Division of Ambulatory Pediatrics (General Pediatrics, i.e., primary care pediatrics). The UH team was provided with information about recent births, and the team approached families before discharge to complete eligibility screening and newborn measures.

Preterm infants at UH were recruited primarily through the Division of Neonatology, Department of Pediatrics. Preterm infants were recruited from the neonatal intensive care unit (NICU) where the highest level of care is provided to critically ill newborns, and the "step-down" unit, also at Rainbow Babies & Children's Hospital, for less critically ill newborns still requiring inpatient care. Most dyads were enrolled during the infant's stay in the step-down unit to ensure that the newborn was stabilized, and that the caregiver(s) was not dealing with an immediate medical crisis. A third source of participants were those infants without serious health care needs born between 35 and 37 weeks of age and discharged home directly after giving birth. Procedures for these infants followed those described above for full-term infants.

Eastern Michigan University Recruitment

Full-term dyads were recruited at Beaumont Pediatrics and term and preterm dyads were recruited from Beaumont OB/GYN Resident Clinic/Perinatology. Uncomplicated, preterm infants who were discharged to home (i.e., < 37-weeks gestation) were also recruited from Beaumont Pediatrics. Office staff provided the informational flyer describing the study to caregivers during their infants' first well-child visits. The team contacted interested caregivers to screen for eligibility.

The Corner Health Center (CHC) also served as a recruitment site for both term and preterm caregiver/infant dyads. A subset of participants at CHC were met to complete study materials at their well-child visits to increase retention. This included completion of both the online and paper surveys.

Informed Consent

The PediaTrac study was approved by the University of Michigan, Institutional Review Board (IRB). The PediaTrac site-specific teams completed phone eligibility interviews to summarize the purpose and procedures of the study. All questions and concerns were addressed prior to involvement in the project and as part of the consent process. Caregivers were given thorough, simplified information regarding the procedures in readily understandable language (i.e., at about the sixth grade reading level) so that the participants understood it (see Appendix B). Once caregivers agreed to participate, procedures were followed as outlined above. An informational sheet explaining the study was sent with the study materials. Caregivers consented to the study by completing the study measures (both digital and paper versions) and returning them to the site.

Data Acquisition

As noted, participants in the study were followed longitudinally from newborn to 18 months of age. At each time period, caregivers completed an online questionnaire, PediaTrac, and a set of paper surveys that have been previously validated and established to serve as tools for construct and content validation of PediaTrac. The online survey was developed and housed in REDCap, a secure online survey and data management system. For the newborn period, the online questionnaire was deployed when the infant reached 39 weeks post conceptual age. For the other time periods, the online questionnaire was sent based on the infant's birth date for full term infants and adjusted birth date for preterm infants. Participants were asked to return surveys after one week, but they had a maximum of 30 days to complete the study materials for each time period. Caregivers were given reminders one and two weeks prior to material due date, and REDCap sent automated reminders three days after the start of the time period. Research assistants reached out, as needed after five days every two days until materials were received or the 30 days was reached. For the newborn time period, an infant could be no more than 4 weeks old at the time of questionnaire completion.

As stated, along with PediaTrac, participants were asked to complete a set of legacy measures that have been previously established and validated at each time period. Participants were given a binder with tabs with the paper legacy measures for each time period. Included in the binder were pre-stamped and addressed envelopes for the participants to use to return the legacy measures to their respective site. Depending on the site and method of recruitment (i.e., over the phone versus in person), participants either received the binder through the mail or in person.

Assessment Measures

PediaTrac

At the newborn period, the module included a demographic section that covered family health history as well as additional caregiver variables. Each time period included the following domains: general medical, sleep, feeding/eating/elimination, early relational health, motor, social sensory information processing, and social/communication/cognition. Questions examining response style were included in each module; the scoring of these scales was under development at the time of the current study. As such, examining response style as a possible covariate was unable to be examined for this investigation. The current study included the social sensory information processing (SSIP) domain.

As noted, the current study utilized the Social-Sensory Information Processing (SSIP) scale of PediaTrac, an experimental scale developed to examine early social attention behaviors (see Appendix C). This scale is comprised of five questions that are asked at each time period beginning in the newborn period (see Table 2). In the prior version of PediaTrac, the social-emotional/communication items consisted of two different types of items – a series of items that inquired about the infant's social-emotional reaction to caregivers (the SSIP questions) and a series of items that addressed social-communication/cognition. Internal consistency reliability (i.e., intraclass correlation coefficient alpha; ICC) of the entire scale, including the SSIP questions was .77 for the newborn period and .80 for the 2-month period (Lajiness-O'Neill et al., 2018). Rasch item response theory (IRT) modeling was used to examine dimensionality of these subdomains separately as well as to examine the total pool of social-emotional/communication items. IRT reliability for the SSIP subdomain was .86 (Lajiness-O'Neill et al., 2018). The caregiver completing the survey was asked to rate the frequency with which the infant engages in the behaviors and with whom. See Figure 4 for an example. The SSIP questions are complex, compound questions that query for social visual and social auditory attention processes, and we contend, precursors to social communication within the context of the infant-caregiver relationship. The questions ask about the child's response to multiple caregivers in their environment, though the current investigation examines only the response to frequency of these behaviors with the primary caregiver. For this investigation, a sum score was calculated to quantify the child's development in these areas. Caregivers indicated how often the infant engages in each of the behaviors ranging from 1 (*never*) to 5 (*always*). ICC for the current sample was .86 and .88 for the newborn and 2-month periods, respectively.

Table 2

Social Sensory Information Processing (SSIP) Questions

Who calms your child by how they touch the child?
Who can calm your child by picking up or holding them?
Whose voice calms your child?
Whose voice causes your child to make eye contact?
With whom does your child make eye contact?

Note. SSIP = Social Sensory Information Processing.

Figure 4

Example of SSIP Question from PediaTrac Survey


PediaTrac

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Who calms your child by how they touch the child?

	Never	Rarely	Sometimes	Often	Always	Not Applicable
Primary caregiver	○	○	○	○	○	○ reset
Secondary caregiver	○	○	○	○	○	○ reset
Sibling(s)	○	○	○	○	○	○ reset
Relative or close family friend	○	○	○	○	○	○ reset
Daycare provider	○	○	○	○	○	○ reset

Note. SSIP = Social Sensory Information Processing.

Legacy Measures

As stated, along with the online PediaTrac questionnaire, participants complete paper legacy measures that have been previously validated. For the current study, the Infant Behavior Questionnaire-Revised Short Form (IBQ-R SF) and Communication and Symbolic Behavior Scales Developmental Profile™ (CSBS DP) were used to examine duration of orienting and social communication, respectively.

The Infant Behavior Questionnaire-Revised Short Form (IBQ-R SF) is a 91-item measure, organized into 14 subscales (Activity Level, Distress to Limitations, Fear, Duration of Orienting, Smile/Laughter, High Intensity Pleasure, Low Intensity Pleasure, Soothability, Falling Reactivity, Cuddliness, Perceptual Sensitivity, Sadness, Approach, and Vocal Reactivity), that is designed to assess infant temperament between the ages of 3 and 12 months (see Appendix D). The frequency of infant behaviors are rated on a scale from 1 (*never*) to 7 (*always*), with higher scores indicating more of each construct. Internal consistency has previously been demonstrated to be good for each of the subscales, as measured by Cronbach's alpha (Putnam et al., 2014). Conceptual and item analyses provided support for 14 of the 16 proposed scales, demonstrating satisfactory internal consistency. Mono-method discriminant validity was demonstrated through an examination of correlations among the IBQ-R SF scale scores. Results of the factor analytic procedure were consistent with three broad dimensions of Surgency/Extraversion (SUR), Negative Affectivity (NEG), and Orienting/Regulation (REG). The REG scale will be used as a primary dependent variable in the current study and includes Duration of Orienting, Low Intensity Pleasure, Soothability, and Cuddliness.

The Communication and Symbolic Behavior Scales Developmental Profile™ (CSBS DP™) Infant-Toddler Checklist is used to identify early delays in social communication, expressive speech/language, and symbolic functioning (see Appendix E). Caregivers respond to 24 multiple choice questions about their child's communication. It is a norm-referenced screening and evaluation tool that helps determine the communicative competence of infants and toddlers, measured by seven language predictors: emotion and eye gaze, communication, gestures, sounds, words, understanding, and object use. From these seven clusters, three composites are generated (Social, Speech, Symbolic). Standard scores and composite percentiles are generated. The composites will serve as primary dependent variables in this study, with the exception of the Speech composite, as the current investigation is primarily focused on nonverbal aspects of social communication. Higher scores reveal better performance. CSBS DP is used with infants and toddlers whose functional communication age is between 6 months and 24 months. CSBS DP was successfully tested for validity and reliability with large samples of children (2,188 for the checklist, 790 for the Caregiver Questionnaire, and 337 for the Behavior Sample). Notably, this tool was not specifically validated on a group of preterm infants.

Participant Tracking

In order to retain study participants over the 18 months, participants were assigned to a particular research assistant (RA) who is responsible for ensuring that they are reminded about upcoming time period due dates for materials. The RA contacts caregivers two weeks and one week before the due date, on the due date, and five days post the due date (if materials have not been received) to ensure that caregivers return the online questionnaire and legacy measures within one week.

Retention Strategies

Upon the receipt of the completed online questionnaire and legacy measures, caregivers are paid. After completion of the newborn materials, participants were paid $20. They are paid

$40 at each subsequent time period and $50 at the 18-month time period. Additionally, caregivers were asked to provide up to three alternate contacts at enrollment that are able to be contacted, should we be unable to reach the caregiver. If an individual misses a single time period with the exception of the baseline, newborn period, they are able to return to the study, should they be interested in doing so.

Data Storage and Management

As stated, the online PediaTrac questionnaire was developed in REDCap, a HIPAA compliant survey and data management system. It is through this system that the questionnaires are deployed via email to participants. All responses are stored in REDCap. When legacy measures are received from participants, they are entered into REDCap and subsequently verified by an additional RA to ensure that no errors in data entry were made. Additionally, REDCap has a calendar feature that allows for RA communication regarding contact with caregivers around due date reminders.

Data Analysis

Sensitivity Analysis

The current study included 571 participants from the larger, NIH-grant-funded study. The current study included the participants recruited and followed through 6 months of age at the time of data analysis, including term and preterm infants.

G*Power (Faul et al., 2007) was used to perform a sensitivity analysis for multiple regression examining longitudinal relations between emerging social attention at newborn and 2 months and social communication and duration of orienting at 6 months. The effect size for this analysis was estimated based on Cohen's (1988) guidelines for medium effect size of 0.15 at 80% power. With five possible predictors entered into the model (SSIP newborn, SSIP 2-month, and gestational age, maternal education, and sex as covariates), two-tailed analyses, with α level set at 0.05, a sample size of at least 107 was needed to detect a minimum effect size of .15. With the sample of 571, the minimum effect size able to be detected with 80% power was .03.

Preliminary Analyses

Descriptive statistics across the sample were computed and assumptions were tested and analyzed prior to execution of hypothesis testing (mean, SD, range). Measures of normality including skewness and kurtosis, homogeneity of variance for the covariates, were also examined for all outcomes, predictors, and covariates. Infant sex and maternal education were included in the model as covariates.

Correlations

Pearson or point-biserial correlation coefficients were computed between continuous predictor variables (SSIP and gestational age), covariates (infant sex and maternal education), and outcome variables (IBQ-R SF REG, CSBS DP), respectively. Scatter plots were examined for each of the correlations to ensure there were no significant outliers. Influential cases were examined in the regression diagnostics.

Regression diagnostics were completed to ensure the assumptions of regression were met. The variance of predictors and multicollinearity (e.g., tolerance, variance inflation factor, condition index) were examined, along with the assumptions of linearity and homoscedasticity of variance in outcome variables (e.g., plots of Z residuals against Z predicted values. Additionally, the following were examined: (a) independence of residuals (e.g., Durbin-Watson); (b) tests for normality of residuals (e.g., P-P plots, histograms); and (c) casewise diagnostics for undue influence (e.g., Cook’s distance, Mahalanobis distance).

Main Analyses

Aim 1. The first aim of the study was to examine relations between gestational age, emerging social attention at newborn and 2 months, and social communication, duration of orienting, and multisensory non-social attention at 6 months. Relationships between predictor and outcome variables with covariates, infant sex and maternal education, were also examined.

Hypothesis 1. Emerging social attention would be significantly positively correlated with social communication and duration of orienting at 6 months.

Analysis 1: Pearson correlations were computed to examine the relations between covariates of infant sex and maternal education, gestational age, and predictor and outcome variables, SSIP sum score at newborn and 2 months and, and Social, Symbolic, and Total scores on the CSBS DP at 6 months.

Aim 2. The second aim of the study was to examine whether gestational age and emerging social attention at newborn and 2 months would be significant predictors of social communication at 6 months.

Hypothesis 2. Gestational age and emerging social attention at newborn and 2 months would predict social, symbolic, and total communication at 6 months such that higher reported emerging social attention would predict higher reported social, symbolic, and total communication at 6 months. Given preterm birth as a known risk factor, it was hypothesized that lower gestational age would predict poorer social, symbolic, and total communication at 6 months.

Analysis 2: Hierarchical regression using forced entry was conducted to examine the amount of variance in social, symbolic, and overall communication, as measured by CSBS DP Social, Symbolic, and Total scores at 6 months, that is accounted for by gestational age and the

SSIP sum score at newborn and 2 months of age. Gestational age, maternal education, and infant sex were entered in Block 1. SSIP newborn was then entered in Block 2 and SSIP 2-month in Block 3.

Aim 3. The third aim of the study was to examine whether gestational age and emerging social attention at newborn and 2 months would be significant predictors of duration of orienting at 6 months.

Hypothesis 3**.** Gestational age and emerging social attention at newborn and 2 months would predict duration of orienting at 6 months such that higher reported emerging social attention would predict higher reported duration of orienting at 6 months. Given preterm birth as a known risk factor, it was hypothesized that lower gestational age would predict poorer duration of orienting at 6 months.

Analysis 3: Hierarchical regression using forced entry was conducted to examine the amount of variance in duration of orienting, as measured by the IBQ-R SF REG score at 6 months, that is accounted for by gestational age and the SSIP sum score at newborn and 2 months of age. Gestational age, maternal education, and infant sex were entered in Block 1. SSIP newborn was then entered in Block 2 and SSIP 2-month in Block 3.

Results

Preliminary Analyses

Descriptive Statistics

There were significant differences between sites on both predictor and outcome variables, such that the EMU/UH group reported higher perceived performance across all attention and communication scales including the IBQ-R SF REG, CSBS DP Total, Symbolic, and Social scores, SSIP newborn, with a large effect size, and SSIP 2-month (see Table 3).

Table 3

Group Comparisons by Site

	EMU/UH		UM		*t*	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
CSBS social	11.05	4.04	10.03	3.34	2.98	.003	.27
CSBS symbolic	10.72	3.64	9.85	2.83	2.92	.004	.26
CSBS total	104.48	20.3	97.41	16.08	4.19	< .001	.38
IBQ-SF REG	5.54	.62	5.33	.61	3.65	< .001	.33
SSIP Newborn	23.41	2.93	21.23	3.22	7.97	< .001	.71
SSIP 2 Months	23.59	2.97	22.53	2.49	4.45	< .001	.38

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. IBQ-R SF = Infant Behavior Questionnaire- Revised Short Form. SSIP = Social Sensory Information Processing.

Regression Diagnostics

Regression diagnostics were conducted to ensure that the assumptions of regression were met and included an examination of (a) normality of predictors, (b) multicollinearity diagnostics, (c) linearity, (d) homoscedasticity, (e) independence of residuals, (f) normality of residuals, and (g), casewise diagnostics for undue influence. All predictors were normally distributed based on skew values. Multicollinearity diagnostics revealed some significant correlations between variables; the correlation coefficients that exceeded .50 were between the subscales of the CSBS DP, which was to be expected. Additionally, there was a strong positive correlation between SSIP newborn and 2-month scores, which was again expected given that the same questions were included at both time periods. Notably, the correlation between SSIP newborn and 2-month scores (r = .64) was below .80, falling below an established cutoff of .80 to indicate the presence of multicollinearity (Katz, 2011). The Variance Inflation Factor was between 1 and 2.07, well below the established cutoff of 10. Tests for normality of residuals were examined with Normal P-P plots and histograms, with revealed normally distributed residuals. Additionally, the tolerance statistic Scatter plots between predictor and outcome variables revealed all nonlinear interactions. Scatter plots between predicted residuals against model residuals revealed no violation of homoscedasticity. The independence of residuals was examined with the Durbin-Watson statistic, and all models fell within the normal range (1.5-2.5) at 1.9. Finally, Cook's distance analyses revealed no influential cases.

Hypothesis 1

Means, standard deviations, and correlations between predictor and outcome variables are reported in Table 4. Gestational age and weeks since date of birth at survey completion were not significantly correlated with social communication or attention variables. Maternal education was significantly negatively correlated with the CSBS Social score, such that lower maternal education was related to higher reported social communication at 6 months. Maternal education was significantly negatively correlated with the CSBS Symbolic score, such that lower maternal education was related to higher reported symbolic communication at 6 months. Maternal education was significantly negatively correlated with the CSBS Total score, such that lower education was related to higher reported total communication at 6 months.

Maternal education was also significantly negatively correlated with the IBQ-R SF REG score, such that lower maternal education was related to higher duration of orienting at 6 months. Maternal education was significantly negatively correlated with the SSIP newborn score, such that lower maternal education was related to higher reported emerging social attention at the newborn period. Maternal education was significantly negatively correlated with the SSIP 2-month score, such that lower maternal education was associated with higher reported emerging social attention at 2 months.

The CSBS Social score was significantly positively correlated with the CSBS Symbolic score, such that higher reported social communication at 6 months was related to higher reported symbolic communication. The CSBS Social score was also significantly positively correlated with the CSBS Total score, such that higher reported social communication at 6 months was related to higher total communication at 6 months. The CSBS Social score was significantly positively correlated with the IBQ-R SF REG score, such that higher reported social communication at 6 months was related to higher duration of orienting at 6 months. The CSBS Symbolic score was significantly positively correlated with the CSBS Total score, such that higher reported symbolic communication at 6 months was related to higher reported total communication at 6 months. The CSBS Symbolic score was significantly positively correlated with the IBQ-R SF REG score, such that higher reported symbolic communication at 6 months was related to higher reported duration of orienting at 6 months. The CSBS Total score was also significantly positively correlated with IBQ-R SF REG, such that higher reported total communication at 6 months was related to higher duration of orienting at 6 months.

Scatter plots for correlations between CSBS DP subtests and SSIP newborn score are presented in the Supplemental Figures 1, 2, and 3. The SSIP newborn score was significantly positively correlated with the CSBS Social score, such that higher reported emerging social attention at the newborn period was related to higher reported social communication at the 6-month period. The SSIP newborn score was significantly positively correlated with the CSBS Symbolic score, such that higher reported emerging social attention at the newborn period was related to higher reported symbolic communication at 6 months. The SSIP newborn score was significantly positively correlated with the CSBS Total score, such that higher reported emerging social attention at the newborn period was related to higher reported total communication at 6 months. Scatter plots for correlations between the IBQ-R SF REG and SSIP newborn score is presented in Supplemental Figure 4. The SSIP newborn score was significantly positively correlated with the IBQ-R SF REG score, such that higher reported emerging attention was related to higher reported duration of orienting at 6 months. The SSIP newborn score was significantly positively correlated with the SSIP 2-month score, such that higher reported emerging social attention at the newborn period was related to higher reported emerging social attention at the 2-month period.

Scatter plots for correlations between CSBS DP subtests and SSIP 2-month score are presented in the Supplemental Figures 5, 6, and 7. The SSIP 2-month score was significantly positively correlated with the CSBS Social score, such that higher reported emerging social attention at the 2-month period was related to higher reported social communication at 6 months. The SSIP 2-month score was significantly positively correlated with the CSBS Symbolic score, such that higher reported emerging social attention at 2 months was related to higher reported symbolic communication at 6 months. The SSIP 2-month score was significantly positively correlated with the CSBS Total score, such that higher reported emerging social attention at 2 months was related to higher reported total communication at 6 months. Scatter plots for correlations between the IBQ-R SF REG and SSIP newborn score is presented in Supplemental Figure 8. The SSIP 2-month score was significantly positively correlated with the IBQ-R SF REG score, such that higher reported emerging social attention at 2 months was related to higher duration of orienting at 6 months.

Table 4

Correlation Matrix for Study Variables

Variable	*n*	*M (SD)*	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Infant Weeks Gestation	571	36.5 (3.64)	—												
2. Weeks Since DOB Newborn	571	4.01 (3.15)	-.92**	—											
3. Weeks Since DOB 2 Month	547	11.79 (3.60)	-.95**	.92**	—										
4. Weeks Since DOB 6 Month	521	29.48 (3.68)	-.94**	.92**	.96**	—									
5. Infant Sex	571	—	.01	-.01	-.04	-.07	—								
6. Maternal Education	571	4.21 (1.94)	.02	-.04	-.01	.44	-.02	—							

Note. Standard deviations are presented in parentheses. DOB = date of birth. CSBS = The Communication and Symbolic Behavior Scales

Developmental Profile. IBQ-R SF = Infant Behavior Questionnaire- Revised Short Form. SSIP = Social Sensory Information Processing.

*$p < .05$. **$p < .01$. ***$p < .001$

Table 4 Continued

Correlation Matrix for Study Variables

Variable	*n*	*M (SD)*	1	2	3	4	5	6	7	8	9	10	11	12	13
7. Maternal Age	570	30.08 (6.03)	-.11*	.11*	.10*	.10*	-.11*	.55**	—						
8. CSBS Social Scaled Score	468	10.6 (3.77)	.01	-.03	-.03	-.02	.04	-.18**	-.11*	—					
9. CSBS Symbolic Scaled Score	468	10.34 (3.33)	.04	-.07	-.04	-.03	.06	-.15**	-.10*	.50**	—				
10. CSBS Total Standard Score	465	101.36 (18.87)	.04	-.07	-.06	-.04	.02	-.21**	-.15**	.87**	.69**	—			
11. IBQ-R SF REG	483	5.45 (.62)	.03	-.05	-.07	-.07	.04	-.15**	-.07	.22**	.23**	.27**	—		
12. SSIP Newborn Primary Caregiver Sum Score	531	22.51 (3.23)	-.05	.03	.03	.04	-.00	-.34**	-.23**	.18**	.19**	.20**	.30**	—	
13. SSIP 2 Month Primary Caregiver Sum Score	523	23.14 (2.82)	-.01	-.02	.00	-.03	.05	-.19**	-.08	.14**	.15**	.16**	.31**	.64**	—

Note. Standard deviations are presented in parentheses. DOB = date of birth. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. IBQ-R SF = Infant Behavior Questionnaire- Revised Short Form. SSIP = Social Sensory Information Processing.

$*p < .05$. $**p < .01$. $***p < .001$

Main Analyses

A three-step hierarchical regression using forced entry was conducted with CSBS Social, CSBS Symbolic, CSBS Total, and IBQ-R SF REG scores as the outcome, separately. Standardized and unstandardized regression coefficients are reported for the four models. Gestational age, infant biological sex, and maternal education were entered into the first block, the SSIP newborn score was entered into the second block, and the SSIP 2-month score was entered into the third block.

Hypothesis 2

Both standardized and unstandardized regression coefficients are reported in Table 5. The first step in the model predicting variance in the CSBS Social score included gestational age, infant biological sex, and maternal education and accounted for 3.5% of the variance in reported social communication at 6 months. Notably, only maternal education made a significant contribution to the model, such that lower maternal education predicted higher reported social communication at 6 months. When the SSIP newborn score was added in the second step, it accounted for an additional 1.6% of variance in reported social communication at 6 months. Maternal education remained a significant predictor even with the addition of the SSIP newborn score in the second block, such that higher reported emerging social attention at the newborn period, as well as lower maternal education predicted higher reported social communication at 6 months. When the SSIP 2-month score was added into the third block, there was no significant change in the variance of the CSBS Social score. In the third block, only maternal education remained a significant predictor of the variance in CSBS Social scores, such that lower maternal education predicted higher reported social communication at 6 months, but overall the model with the SSIP 2-month score was not significant.

Table 5

SSIP Predicting CSBS Social at 6 Months

	B	95% CI *LL*	95% CI *UL*	*SE B*	*β*	R^2	ΔR^2
Step 1						.035	.035**
Constant	11.58***	7.69	15.48	1.98			
Infant sex	.19	-.53	.91	.37	.03		
Maternal education	-.36***	-.54	-.18	.09	-.19***		
Gestational age	.02	-.09	0.12	.05	.01		
Step 2						.05	.016**
Constant	7.70**	2.89	12.51	2.45			
Infant sex	.21	-.51	0.92	.36	.03		
Maternal education	-.28**	-.47	-.09	.10	-.15**		
Gestational age	.02	-.08	.12	.05	.02		
SSIP newborn	.15**	.04	.26	.06	.13**		
Step 3						.055	.003
Constant	6.05*	.54	11.56	2.80			
Infant sex	.18	-.53	.90	.36	.02		
Maternal education	-.28**	-.47	-.09	.10	-.15**		
Gestational age	.03	-.08	.13	.05	.03		
SSIP newborn	.09	-.07	.24	.08	.08		
SSIP 2 month	.12	-.08	.32	.10	.08		

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

The first step in the model predicting variance in the CSBS Symbolic score included gestational age, infant biological sex, and maternal education and accounted for 3% of the variance in reported symbolic communication at 6 months (see Table 6). Consistent with the above reported model, only maternal education made a significant contribution to the model, such that lower maternal education predicted higher reported symbolic communication at 6 months. When the SSIP newborn score was added in the second step, it accounted for an additional 2.5% of variance in reported symbolic communication at 6 months. Maternal education remained a significant predictor even with the addition of the SSIP newborn score in the second block, such that higher reported emerging social attention at the newborn period, as well as lower maternal education predicted higher reported symbolic communication at 6 months. When the SSIP 2-month score was added into the third block, there was no significant change in the variance of the CSBS Symbolic score. In the third block, both maternal education and the SSIP newborn score remained significant predictors of the variance in CSBS Symbolic scores, such that lower maternal education and higher SSIP newborn scores predicted higher reported symbolic communication at 6 months, but the model overall was not significant.

Table 6

SSIP Predicting CSBS Symbolic at 6 Months

	B	95% CI *LL*	95% CI *UL*	*SE B*	*β*	*R2*	*ΔR2*
Step 1						.03	.03**
Constant	8.89***	5.47	12.30	1.74			
Infant sex	.28	-.35	.91	.32	.04		
Maternal education	-.26**	-.42	-.10	.08	-.15**		
Gestational age	.07	-.02	.16	.05	.07		
Step 2						.055	.025**
Constant	4.69*	.49	8.89	2.14			
Infant sex	.29	-.33	.92	.32	.04		
Maternal education	-.18*	-.34	-.01	.08	-.11*		
Gestational age	.08	-.02	.17	.05	.08		
SSIP newborn	.16**	.07	.26	.05	.17**		
Step 3						.055	.00
Constant	4.16	-.66	8.98	2.45			
Infant sex	.29	-.34	.91	.32	.04		
Maternal education	-.18*	-.34	-.01	.09	-.10*		
Gestational age	.08	-.01	.17	.05	.08		
SSIP newborn	.14*	.01	.27	.07	.15*		
SSIP 2 month	.04	-.13	.21	.09	.03		

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

$*p < .05$. $**p < .01$. $***p < .001$.

The first step in the model predicting variance in the CSBS Total score included gestational age, infant biological sex, and maternal education and accounted for 4.6% of the variance in reported total communication at 6 months (see Table 7). Again, only maternal education made a significant contribution to the model, such that lower maternal education predicted higher reported total communication at 6 months. When the SSIP newborn score was added in the second step, it accounted for an additional 2% of variance in reported total communication at 6 months. Maternal education remained a significant predictor even with the addition of the SSIP newborn score in the second block, such that higher reported emerging social attention at the newborn period, as well as lower maternal education predicted higher reported total communication at 6 months. When the SSIP 2-month score was added into the third block, there was no significant change in the variance of the CSBS Total score. In the third block, only maternal education remained a significant predictor of the variance in CSBS Total scores, such that lower maternal education predicted higher reported total communication at 6 months, but the model overall was not significant.

Table 7

SSIP Predicting CSBS Total at 6 months

	B	95% CI *LL*	95% CI *UL*	*SE B*	*β*	R^2	ΔR^2
Step 1						.046	.046***
Constant	98.63***	79.28	117.97	9.84			
Infant sex	.07	-3.49	3.62	1.81	.00		
Maternal education	-1.98***	-2.88	-1.08	.46	-.21***		
Gestational age	.32	-.20	.83	.26	.06		
Step 2						.068	.02**
Constant	76.20***	52.44	99.96	12.09			
Infant sex	.17	-3.35	3.69	1.79	.00		
Maternal education	-1.53**	-2.47	-.59	.48	-.16**		
Gestational age	.35	-.16	.86	.26	.07		
SSIP newborn	.86**	.32	1.40	.28	.16**		
Step 3						.071	.003
Constant	68.95***	41.79	96.11	13.82			
Infant sex	.07	-3.45	3.59	1.79	.00		
Maternal education	-1.52**	-2.45	-.58	.48	-.16**		
Gestational age	.38	-.13	.89	.26	.07		
SSIP newborn	.58	-.16	1.32	.38	.11		
SSIP 2 month	.54	-.44	1.51	.50	.07		

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

*$p < .05$. **$p < .01$. ***$p < .001$.

Contrary to the hypothesis, gestational age was not a significant predictor of the variance in CSBS Social, Symbolic, or Total scores. Maternal education remained a significant predictor of the variance in scores in all models with CSBS Social, Symbolic, and Total scores as outcome variables. Consistent with the hypothesis, SSIP newborn was a significant predictor of the variance in scores across models with CSBS Social, Symbolic, and Total scores as outcomes when entered in the second block; it uniquely contributed to the variance in scores across all three models. The addition of the SSIP 2-month score did not significantly or uniquely contribute to the variance in social communication scores across the models. In fact, in the Social and Total score models, the addition of SSIP 2 months eliminated the contribution of SSIP newborn to the variance in scores, and maternal education remained as the only significant predictor of variance in the scores.

To examine the unique contribution of SSIP newborn and SSIP 2 months to the variance in outcomes in CSBS DP scores at 6 months, post-hoc models examining SSIP newborn and SSIP 2-month scores as independent predictors are reported in the supplemental tables. In the model predicting CSBS Social scores at 6 months, maternal education and SSIP newborn accounted for a similar amount of variance in CSBS Social score at 6 months (see Supplemental Table 1). When SSIP 2 months was entered as a predictor in the model, maternal education accounted for more variance than SSIP 2 months in the CSBS Social score at 6 months (see Supplemental Table 2). Reported emerging social attention at 2 months was the weakest predictor of reported social communication at 6 months.

In the model predicting CSBS Symbolic scores at 6 months, SSIP newborn was a stronger predictor than maternal education of the variance in CSBS Symbolic scores at 6 months (see Supplemental Table 3). When SSIP 2-month was entered as a predictor in the model, maternal education and SSIP 2-month scores accounted for a similar amount of the variance in outcomes in CSBS Symbolic score at 6 months (see Supplemental Table 4). Reported emerging social attention at the newborn period was the strongest predictor of reported symbolic communication at 6 months.

In the model predicting CSBS Total scores at 6 months, SSIP newborn scores and maternal education accounted for a similar amount of the variance in CSBS Total scores at 6 months (see Supplemental Table 5). When SSIP 2-month was entered as a predictor in the model, maternal education was a stronger predictor than SSIP 2-month scores of the variance in CSBS Total scores at 6 months (see Supplemental Table 6). Reported emerging social attention at the 2-month period was the weakest predictor of reported overall communication at 6 months.

Hypothesis 3

Both standardized and unstandardized regression coefficients are reported in Table 8. The first step in the model predicting variance in the IBQ-R SF REG score included gestational age, infant biological sex, and maternal education and accounted for 4% of the variance in reported duration of orienting at 6 months. Notably, only maternal education made a significant contribution to the model, such that lower maternal education predicted higher reported duration of orienting at 6 months. When the SSIP newborn score was added in the second step, it accounted for an additional 7% of variance in reported duration of orienting at 6 months. Maternal education remained a significant predictor even with the addition of the SSIP newborn score in the second block, such that higher reported emerging social attention at the newborn period, as well as lower maternal education predicted higher reported duration of orienting at 6 months, though the SSIP newborn score predicted more of the variance. When the SSIP 2-month score was added into the third block, it accounted for an additional 1% of the variance in the IBQ-R SF REG score and remained significant. In the third block, maternal education no longer significantly contributed to the variance in IBQ-R SF REG scores at 6 months. Both SSIP newborn and 2-month scores significantly contributed to the variance in IBQ-R SF REG scores at 6 months, such that higher reported emerging social attention at the newborn and 2-month periods predicted higher reported duration of orienting at 6 months.

Contrary to the hypothesis, gestational age was not a significant predictor of variance in IBQ-R SF REG scores at 6 months. Maternal education was a significant predictor in the first and second blocks but only approached significance in the third block. Consistent with the hypothesis, the SSIP newborn score was a significant predictor when it was entered into the second block and remained a significant predictor when the SSIP 2-month score was entered into the third block.

To examine the unique contribution of SSIP newborn and SSIP 2 months to the variance in outcomes in IBQ-R SF scores at 6 months, post-hoc models examining SSIP newborn and SSIP 2-month scores as independent predictors are reported in the supplemental tables. In the model predicting IBQ-R SF REG scores at 6 months, SSIP newborn was a more significant predictor than maternal education of the variance in IBQ-R SF scores at 6 months (see Supplemental Table 7). Similarly, the SSIP 2-month was a more significant predictor than maternal education of the variance in CSBS Total scores at 6 months (see Supplemental Table 8). Reported emerging social attention at the newborn and 2-month periods accounted for a similar amount of variance in duration of orienting at 6 months.

Table 8

SSIP Predicting IBQ-R SF at 6 Months

		95% CI					
	B	*LL*	*UL*	*SE B*	*β*	*R2*	*ΔR2*
Step 1						.04	.04**
Constant	5.72***	5.11	6.33	.31			
Infant sex	.06	-.05	.18	.06	.05		
Maternal education	-.06***	-.09	-.03	.02	-.18***		
Gestational age	-.00	-.02	.02	.01	-.01		
Step 2						.11	.07***
Constant	4.38***	3.65	5.12	.38			
Infant sex	.07	-.04	.18	.06	.06		
Maternal education	-.03*	-.06	.00	.02	-.10*		
Gestational age	.00	-.02	.02	.01	.01		
SSIP newborn	.05***	.03	.07	.01	.28***		
Step 3						.12	.01*
Constant	3.90***	3.07	4.74	.43			
Infant sex	.06	-.05	.17	.06	.05		
Maternal education	-.03	-.06	.00	.02	-.09		
Gestational age	.00	-.01	.02	.01	.01		
SSIP newborn	.03**	.01	.06	.01	.18**		
SSIP 2 month	.04*	.01	.07	.02	.15*		

Note. IBQ-R SF = Infant Behavior Questionnaire- Revised Short Form. SSIP = Social Sensory Information Processing.CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

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

Discussion

The current study measured social attention using an experimental domain, the Social-Sensory Information Processing (SSIP) scale of PediaTrac. The SSIP questions are complex, compound questions that query for social visual and social auditory attention and response to caregivers. The current investigation examined only responses to the primary caregiver. The five SSIP questions are asked for the first time at the newborn period and are repeated at each subsequent sampling period; responses to SSIP newborn and 2 months were included in the current study.

The current investigation aimed to address gaps in the literature by examining relations between early social attention via caregiver report at newborn and 2 months of age and social, symbolic, and overall communication, and attentional orienting and regulation at 6 months. Beyond simple relationships, the study also aimed to identify whether social attention behaviors (as operationalized by the SSIP scale of PediaTrac) at the earliest time periods are predictive of social, symbolic, and overall communication via the CSBS DP and duration of orienting via the IBQ-R-SF at 6 months, given that 6 months is essentially the earliest time at which current caregiver-report measures assess these constructs (Wetherby & Prizant, 2001) and when important social communication behaviors are thought to emerge (Morales et al., 2005; Mundy, 2018; Mundy & Newell, 2007). Additionally, the current study included a large, representative sample with sociodemographic and socioeconomic diversity allowing for an important examination of the impact of these variables on caregiver-reported social attention, social, symbolic, and overall communication and duration of orienting.

Aim 1

Caregiver-reported emerging social attention (SSIP) at newborn and 2 months was significantly positively correlated with the Social, Symbolic, and Total scales of the CSBS DP at 6 months. This may indicate that emerging social attention as measured with SSIP is capturing pivotal social and/or communicative behaviors in the first weeks of life that are precursors to social, symbolic, and overall communication behaviors emerging at 6 months. This is consistent with the notion that behaviors emerging in the first days of life are critical to successful social communication development (Blasi et al., 2011; Farroni et al., 2002; Frank et al., 2014; Lloyd-Fox et al., 2012; Mehler et al., 1978). Interestingly, SSIP at 2 months was more strongly correlated than SSIP newborn with duration of orienting and early regulation at 6 months. Importantly, the IBQ-R SF REG scale includes items that query for the ability to orient and sustain attention to both social and non-social stimuli, as well as emerging regulatory skills, such as soothing in response to caregivers, which may have overlapped with some of the items on the SSIP scale (Gartstein & Rothbart, 2003). For example, the Soothability subscale of the IBQ-R SF includes questions about how long it takes for the infant to soothe, and the Cuddliness subscale queries about the infant's preference for being held (Putnam et al., 2014). While these subscales have some overlap with SSIP questions, they do not query the infant's *social* response to the caregiver, per se. For example, the SSIP questions ask caregivers to report on the infant's response to various sensory input from the caregiver (i.e., calming more specifically to caregiver's touch and voice) and visual attention to the caregiver (i.e., eye contact).

Importantly, there was also range restriction in reporting of SSIP at newborn and 2 months such that caregivers generally reported close to the maximum score at both time periods. This likely impacted the correlations between scores on SSIP and scores on the CSBS DP and

IBQ-R SF, and as a result, these relations should be interpreted cautiously. Range restriction can affect correlations between variables, such that it reduces the standard deviation and subsequent correlation (Pfaffel & Spiel, 2016), increasing the potential for a Type II error.

To examine whether there was a differential pattern of outcome in predicting caregiver reported social, symbolic, and overall communication and attentional abilities due to prematurity, this sample included preterm infants. Contrary to the hypothesis, gestational age of the infant was not related to reported performance across attention and communication variables in the current investigation. In 2020, 1 of every 10 infants in the United States was born preterm (Centers for Disease Control, 2021). Despite the prevalence of preterm birth and that risk for attentional, social, and communication difficulties is well documented in children born preterm (Fitzallen et al., 2020; Larsen et al., 2021), when and how these processes are impacted is not yet fully understood.

A systematic review by Dean and colleagues (2021) investigating social cognition (a broad term that includes social and communicative behaviors) in children born preterm found that there are inconsistencies and instability of emerging social cognition over the first year of life in children born preterm. They found there was generally a pattern of reduced social attention over the first year of life, as measured by eye tracking, but the studies included varied greatly with regard to when and how they measured social attention (Dean, Ginnell, Boardman, et al., 2021). Decreased gaze following is reported as early as 3 months in some studies, while others do not report differences between term and preterm groups until 9 months (Dean, Ginnell, Ledsham, et al., 2021). It may be that the current investigation measured these constructs too early to detect differences due to gestational age.

Another important consideration in the current study is that caregivers of preterm infants were not able to be enrolled until their child reached a corrected age of 39 weeks gestation. Had age correction not occurred at enrollment, clearer relations between gestational age and caregiver reported emerging social attention, social, symbolic and overall communication and duration of orienting may have emerged (Harel-Gadassi et al., 2018; Morsan et al., 2018). Age correction in a developmental study using the MSEL in infants born at or before 34 weeks gestation found that use of age corrected norms versus chronological age-based norms resulted in fewer infants identified as having delayed development (Harel-Gadassi et al., 2018). The authors argue that both chronological and age-corrected norms should be used in clinical practice and research to accurately characterize preterm infants. Notably, in the current investigation, a variable measuring "weeks since date of birth" was included in the preliminary analyses examining bivariate correlations to account for possible effects of older chronological age in preterm infants. There were no significant relations between weeks since date of birth and predictor or outcome variables. Again, range restriction in the SSIP variables may have limited our ability to detect an effect between gestational age and SSIP but cannot account for the lack of relationship between gestational age and the other predictor or outcome variables.

Aim 2

Contrary to the hypothesis, gestational age was not a significant predictor of social, symbolic, or overall communication at 6 months; as stated, gestational age was not related to any of the variables in the current investigation. Consistent with the hypothesis that emerging social attention would predict social, symbolic, and total communication at 6 months, SSIP newborn was a significant predictor of all CSBS DP scores, such that higher reported emerging social attention at the newborn period predicted higher reported social, symbolic, and overall communication. The addition of the 2-month SSIP score did not improve the model or significantly predict social, symbolic, or overall communication.

SSIP newborn remained significant in the model predicting symbolic communication, such that both lower maternal education and higher reported emerging social attention at the newborn period predicted higher symbolic communication at 6 months (e.g., “Does your child nod his/her head to indicate yes?”). Additionally, post-hoc analyses revealed that SSIP newborn was the strongest predictor of CSBS Symbolic at 6 months. Notably, SSIP newborn and SSIP 2 month are highly correlated (r = .64). As such, the addition of SSIP at 2 months did not appear to further contribute to the model in predicting variance in the CSBS Symbolic scores at 6 months. This finding potentially suggests that emerging social attention as measured by SSIP at the newborn period captures key behaviors that underlie nonverbal social communication behaviors, such as use of gestures, emerging at 6 months, and measurement of SSIP at the subsequent 2-month period likely provides no additional benefit to our understanding of this relationship. The results are consistent with the model of social communication proposed by Wiseman-Hakes and colleagues (2020) that emphasized integration of several cognitive functions necessary for successful development of social communication. As stated, joint attention is a key nonverbal social communication behavior that is just beginning to emerge at 6 months (Mundy, 2018; Mundy et al., 2010; Mundy & Newell, 2007), and it appears as though caregivers are able to report on social attention behaviors such as eye gaze and interactions with the caregiver that may be particularly important for nonverbal social communication development at 6 months.

Importantly, there was no direct observation of emerging social attention in the current investigation. It may be that the caregivers’ report on the SSIP scale captured the infant’s arousal and alertness, rather than specifically capturing emerging social attention. That said, literature would suggest that infant's ability to direct attention before 3 months of age is in large part determined by the infant's alertness before attention becomes cortically mediated (Colombo, 2001), and reduced visual attention at 2 to 3 months has been associated with poorer social communication development at 12 months (Bradshaw et al., 2021). Further investigation including a direct assessment of behavior along with SSIP would allow for better understanding of the validity of the SSIP scale. While reliability of the scale has been established in the initial validation of the PediaTrac tool, the scale requires further validation.

A key finding of the current investigation is that maternal education was significantly negatively related to all of the predictor and outcome variables (SSIP newborn and 2 months, CSBS Social, Symbolic, and Total and IBQ-R SF REG at 6 months), such that maternal education was inversely related to caregiver reported emerging social attention, social, symbolic, and overall communication, and duration of orienting. This was a somewhat unexpected finding, as demographic variables such as lower maternal education or younger caregiver age are typically viewed as risk factors for poorer developmental outcomes (Justice et al., 2020). That said, some studies suggest that educational attainment of the caregiver may impact knowledge about infant development and thus impact how they report on their child's development (Rowe et al., 2016). The current study adds to the existing developmental literature by including a sample of caregivers with a range of educational attainment, socioeconomic status, and racial and ethnic backgrounds (Lajiness-O'Neill et al., 2021). Understanding how caregiver report measures perform in diverse samples is imperative to the generalizability of findings (Bosquet Enlow et al., 2016; Rivera Mindt et al., 2010; Rowe et al., 2016). Many research and clinically-based tools to assess aspects of development are created by and validated on predominately White, highly educated samples that are not representative of the United States population (e.g., Cory, 2021;

Rivera Mindt et al., 2010). It may be that clinical and research tools behave differently in more diverse populations.

For example, a study by Bosquet Enlow and colleagues (2016) found that the IBQ-R scales may be rated differently across culturally diverse samples. In a sociodemographically diverse sample of caregivers, the REG factor structure differed such that soothability and cuddliness no longer loaded onto the REG factor, as in the original structure (Bosquet Enlow et al., 2016). The authors highlighted the importance of including representative samples in the validation of caregiver report tools. Because research including diverse samples in systematic, longitudinal investigations is limited, it remains unclear whether differences in caregiver report are attributed to caregiver's perceptions or whether they indicate true behavioral differences between infants of diverse backgrounds (Blacher et al., 2019; Bosquet Enlow et al., 2016; Rowe et al., 2016).

Notably, the impact of sociodemographic risk factors such as socioeconomic status on developmental outcomes is not well understood (Roigé-Castellví et al., 2021), and the impact of structural inequality on health outcomes in children requires further elucidation (Berry et al., 2021). Dean and colleagues (2021), in their systematic review of the development of social cognition in preterm infants identified that preterm birth alone was not the sole driver of reduction in the quality of social interactions between preterm infants and their caregivers. Sociodemographic factors and maternal mental health also contributed to the variability in the quality of social interactions across children born full term and preterm (Dean, Ginnell, Boardman, et al., 2021).

Maternal education was a significant predictor of social, symbolic, and overall communication, such that lower maternal education predicted higher performance on all measures of the CSBS DP. It could be that caregivers with higher education reported less developed attentional and communication skills overall, or conversely, caregivers with less education may have reported stronger attentional and communication skills. A seminal study by Feldman and colleagues (2000) found that caregivers with lower education demonstrated a pattern of overestimating their infants' language development. Maternal education was the strongest predictor of variance in reported social communication at 6 months, regardless of the addition of emerging social attention in the models. As stated, the impact of sociodemographic factors, such as maternal education, on infant development, as well as on the caregiver's perception of their infant's development is an area that requires further study (Blacher et al., 2019; Glascoe & Leew, 2010; Rowe et al., 2016).

Aim 3

Contrary to the hypothesis that earlier gestational age would predict lower reported duration of orienting at 6 months, gestational age was not a significant predictor of variance in duration of orienting at 6 months. Maternal education was also a significant predictor of duration of orienting, such that lower maternal education predicted higher reported duration of orienting at 6 months. This finding is consistent with the findings reported for the social, symbolic, and overall communication scales, though maternal education appeared to be responsible for less variance in IBQ-R SF REG scores compared to the CSBS DP scores. As stated, the IBQ-R SF REG scale includes both social and non-social questions (Putnam et al., 2014). The REG scale may perform differently in more diverse populations, specifically, the social subscales (Soothability and Cuddliness; Bosquet Enlow et al., 2016).

Consistent with the hypothesis that reported emerging social attention would predict reported duration of orienting at 6 months, the SSIP newborn score was a significant predictor of the IBQ-R SF as was the SSIP 2-month score, such that higher reported emerging social attention predicted higher duration of orienting at 6 months. Overall, the SSIP newborn score was just as strong a predictor as the SSIP 2-month score in accounting for the variance of duration of orienting at 6 months, suggesting that emerging social attention reported by caregivers at the newborn period is a key predictor of duration of orienting at 6 months, and with minimal additional contribution in outcome noted from the SSIP 2-month score.

The IBQ-R SF REG scale is comprised of questions about both social and non-social attention behaviors based on factor analytic studies of the original measure (Gartstein & Rothbart, 2003; Putnam et al., 2014). Additionally, this scale includes questions about emerging self-regulatory processes, including how the infant calms and soothes in response to input from the caregiver (Gartstein & Rothbart, 2003), which are inherently social processes. While the IBQ-R SF is one of the earliest measures to assess self-regulatory and attentional skills at 3 months of age, the PediaTrac SSIP scale may be able to “capture” these skills as early as the newborn period. The findings from the current investigation suggest that caregivers can report on emerging social attention from the earliest days of life in such a way that predicts attentional orienting (including both social and non-social aspects) and early regulatory capacity at 6 months of age.

Additionally, caregiver reported emerging social attention at the newborn period appears to be a particularly important predictor of duration of orienting at 6 months. The addition of reported emerging social attention at 2 months only slightly enhances the prediction of duration of orienting at 6 months. These findings further suggest that how infants are orienting their attention to caregivers in the environment and responding to their primary caregiver (e.g., calming in response to sensory input) in the newborn period can be measured via caregiver report.

Clinical Implications

A primary aim of the study was to determine whether there are observable, emerging social attention behaviors in the first days to weeks of life that can be measured by caregiver report. As stated, there was range restriction in scores on the SSIP newborn and 2-month scales, and as a result, findings may have been impacted such that the relationships between SSIP and CSBS DP and IBQ-R SF scores may have been underestimated (Pfaffel & Spiel, 2016). That said, despite this, SSIP scores were a significant predictor of later reported social, symbolic, and overall communication, and duration of orienting at 6 months of age and supports the ongoing development of caregiver report questionnaires that begin at the newborn period. There remains a lack of clarity with regard to which milestones at the earliest time periods may confer risk for atypical development, and with that, there is a lack of caregiver report measures that assess for these behaviors beginning in the newborn period (Salley & Colombo, 2016). Current guidance on milestones either collapses milestones over the first 3 months (e.g., Mayo Clinic, 2022) or does not begin until 2 months of age (e.g., CDC, 2022). Clarifying key developmental milestones, such as the emergence of social attention behaviors as early as the newborn period may lead to opportunities to identify atypical development earlier, resulting in opportunities for early intervention.

As stated, there has not yet been a study that has examined how emerging social attention at the newborn and 2-month periods, as measured by caregiver report, is able to predict caregiver reported communication and duration of orienting at 6 months. In the initial validation of the CSBS DP, Wetherby and colleagues (2002) found that caregiver report of communication development with the three core subtests of the CSBS DP (social, symbolic, and speech) measured at 12 to 16 months of age accounted for between 22% of the variance in expressive language outcome and 26% of receptive language outcome at 2 years measured by the MSEL or Preschool Language Scales. The symbolic subscale of the CSBS DP accounted for 22% of variance in receptive language outcome and was the strongest individual subscale in predicting language outcome at 12 months, which was the earliest time point included in the study (Wetherby et al., 2002). Watt and colleagues (2006) also examined the predictive value of the CSBS DP Behavioral Scales (i.e., a direct observation examining communication behaviors corresponding to the subscales on the CSBS DP) in the second year of life and its ability to predict receptive and expressive language outcomes at 3 years. Their findings revealed that observed social and symbolic behaviors at 14 months of age (e.g., use of gestures, response to joint attention, initiation of joint attention, symbolic play, and simple comprehension) accounted for 24% of receptive language outcomes, as measured by the MSEL at 3 years of age. The findings of the current investigation revealed that models including the covariates of sex, maternal education, gestational age, and the SSIP scores only accounted for between 5% and 7% of the variance in caregiver reported communication and duration of orienting at 6 months. SSIP was not as strong a predictor of later outcomes as those reported in other investigations, but again, this study aimed to understand caregiver's ability to report on the earliest emerging social attention behaviors and their ability to predict later communication and attention development at 6 months, when critical behaviors, such as RJA begin to emerge. Both of these studies included infants at least 12 months or older, and as stated, there are not yet caregiver report tools that begin at the newborn period examining emerging social attention. It could be that addition of a scale, such as SSIP, administered at the newborn period could improve predictive ability of caregiver report tools over time.

As stated, there are currently tools that directly assess motor, language, and cognitive development starting in the newborn period (Bayley, 2006; Luttikhuizen dos Santos et al., 2013; Mullen, 1995), but these only examine attention and social communication behaviors within the context of language or general cognitive domains. Additionally, these tools are costly and difficult to access due to a lack of available providers (Shipman et al., 2011). Available caregiver report tools to assess aspects of attentional development are not able to be administered until 3 months of age (i.e., IBQ-R; Gartstein & Rothbart, 2003). With that, the IBQ-R is a research tool and not used clinically. While there are clinical tools that assess general communication early in infancy (e.g., ASQ; Squires et al., 2009), there are no measures of social communication at the newborn period. Additionally, there is no caregiver report tool that assesses emerging social attention beginning in the newborn period, though the findings of the current study suggest that caregivers may be capable of reporting on social attention behaviors in a way that is meaningfully related to and predictive of their report at 6 months when known social communication and attention behaviors are beginning to emerge (i.e., RJA; Mundy & Newell, 2007).

Finally, it will be critical for validation of new tools to include diverse samples that are representative of the greater U.S. population to ensure generalizability of findings (Rivera Mindt et al., 2010; Roberts et al., 2020). Additionally, it will be essential to understand the impact of health inequities on infant development. Increasing accessibility of developmental tracking tools is a necessary step to building large, representative research and clinical databases, as well as decreasing disparities due to systemic barriers to accessing care (Blacher et al., 2019; Shipman et al., 2011; Unaka et al., 2022). The findings of the current study are a promising step to achieving these goals and suggest that a tool like PediaTrac may be particularly well suited to meet these needs (Lajiness-O'Neill et al., 2021).

Limitations

While the current study added to the existing literature, there are important limitations to consider. As previously stated, there was range restriction in the SSIP newborn and 2-month scores. Lack of variability in scores on the SSIP scales likely impacted the relations with scores on the CSBS DP and IBQ-R SF, and its ability to predict these outcomes. The current investigation may have benefited from adjusting for range restriction to minimize the risk of type II error (Pfaffel & Spiel, 2016; Picardi & Masick, 2013). As previously stated, the SSIP scale is an experimental scale that includes complex, compound questions that query for social visual and social auditory attention processes, that are understood as precursors to social communication within the context of the infant-caregiver relationship. The internal consistency for the SSIP scale was .86 for newborn and .88 for 2 months, indicating adequate reliability of the scale (Tavakol & Dennick, 2011). This scale requires further validation which will occur as part of the larger PediaTrac study. Factor analytic methods are a necessary step to determining the validity of this scale.

Another limitation to the current study was a lack of inclusion of a direct measure of social attention to assist with further construct validation of the SSIP scale, making the results susceptible to monomethod bias. There is not yet a direct observation clinical tool that could serve as an external criterion measure for social attention, though use of a measure like the Bayley-4 or MSEL could assist with establishing predictive validity to understand how caregiver reported SSIP at the newborn and 2-month periods may be related to or predictive of later motor, language, and cognitive development, as has been demonstrated with measures like the CSBS DP (Watt et al., 2006; Wetherby et al., 2002). Experimental tools, such as eye gaze tracking or a joint attention measure such as the Early Social Communication Scales (ESCS; Mundy et al., 2003) could also potentially serve as a direct measure to assist with establishing construct and predictive validity of SSIP. Additionally, a measure of response bias was not included in the current investigation that may have been useful in understanding the impact of caregiver response styles on reporting of social, attentional, and communication development (Taylor et al., 2014). Notably, a measure of embedded validity is included in the larger PediaTrac study and will be part of the validation of the tool, but the scale is under development. A combination of direct observation and an embedded measure of response style within the PediaTrac scales would allow for better understanding of how caregiver report compares to the observed behavior of the child and would improve understanding of how over- or under-reporting by caregivers may have impacted the findings of the current study.

There was limited investigation of differences across sites regarding sociodemographic differences that may have contributed to the significant differences in reporting on emerging social attention, communication, and duration of orienting. As stated, caregivers from the EMU/UH group reported significantly higher scores across SSIP, CSBS DP, and IBQ-R SF compared to those at UM. This finding deserves further clarification to understand sociodemographic factors that contribute to infant development, as well as response styles on caregiver report measures, such as PediaTrac (Blacher et al., 2019; Glascoe & Leew, 2010; Roigé-Castellví et al., 2021; Rowe et al., 2016).

Finally, the exclusion criteria for both the term and preterm samples excluded those with relatively common complications and clinical presentations (e.g., Down Syndrome, prenatal substance exposure), which may limit the generalizability of findings. It may be possible that clearer differences in caregiver reported social and attentional development may have surfaced if more preterm infants born with medical complications had been included, as degree of prematurity is associated with increased risk for later cognitive problems (Brydges et al., 2018; Córcoles-Parada et al., 2019).

Future Directions

A primary goal of developmental research is understanding trajectories of the development of pivotal behaviors in infancy. Multidomain assessment will be key to understanding how individual skills develop, integrate, and coordinate over time and for identifying which behaviors may be most indicative of risk for atypical development (Lajiness-O'Neill et al., 2021). Additionally, assessment that includes sociodemographic and environmental risk will also be important to elucidating their impact on infant development to inform healthcare and policy change (Gouge et al., 2020). Ideally, further research will include both direct and caregiver report assessment methods to reduce the impact of possible bias and assist in the validation of caregiver report tools.

Inclusion of variables such as environmental risk, area deprivation indices, caregiver variables (e.g., level of education), and deeper understanding of sociodemographic and cultural factors that may influence child rearing, as well as how caregivers perceive their infant’s development is critical to ensuring accuracy of caregiver report that will lead to more sensitive screening of risk factors for atypical development (Singh & Lin, 2019). For example, in the current investigation, there were significant site differences in reporting that may have interacted with other aspects of development, like gestational age. This supports multidomain assessment methods that will ensure more accurate risk and trajectory mapping over time.

Early identification of atypical development could lead to opportunities for earlier intervention, ultimately improving developmental outcomes. Additionally, early characterization of risk factors for atypical development could lead to the development of targeted interventions that address behaviors that are most indicative of risk (Vivanti et al., 2018). Caregiver report is a much less costly and more widely accessible method for tracking infant development. Additionally, assessment tools that begin during the newborn period and can be repeated over time, such as PediaTrac, will also allow for building trajectories over time so that children are not only compared to a normative sample, but allow for children to be compared to themselves to better characterize developmental plateaus or regressions (Thomas et al., 2009; Fountain et al., 2012; Twisk & Hoekstra, 2012).

Investigation of caregiver report tools, such as SSIP in conjunction with neuroimaging and direct assessment of development will allow for an understanding of the neural underpinnings of key behaviors, such as social attention. Additionally, further study with brain imaging will hopefully lead to the identification of brain-based biomarkers of clinical disorders such as ASD. It may be that brain abnormalities precede behavioral markers of atypical development, and a combination of behavioral ratings and imaging findings will likely increase the accuracy of predictive models in infancy (Ayoub et al., 2022).

Conclusion

This is the first study to assess whether caregivers could report on emerging social attention behaviors in the first days to weeks of life with a novel, experimental scale (PediaTrac SSIP) and whether there were relationships between this purported social attention construct and communication and attentional orienting and emerging self-regulatory abilities at 6 months of age. The social attention construct demonstrated internal consistency, and caregivers are able to reliably report on this construct over time. The findings revealed that caregivers reported on these behaviors in a way that was predictive of social, symbolic, and total communication and duration of orienting at 6 months, when key nonverbal social communication and attention behaviors (e.g., joint attention) are emerging. Maternal education was significantly negatively related to and predictive of caregiver reported social, communication, and attentional development. This is consistent with findings that parental education impacts knowledge about development. Still, this finding deserves further study to determine what may contribute to differences in reported development across caregivers from different sociodemographic backgrounds and to consider opportunities for intervention. Reported emerging social attention measured with SSIP at the newborn period was the best predictor of reported nonverbal social communication and duration of orienting at 6 months, suggesting that caregivers may be able to identify key behaviors in the first days of life that may underlie nonverbal social communication and duration of orienting at 6 months. Gestational age was not a significant predictor in any of the models, perhaps due to age correction for preterm infants or influence of other site differences that impacted caregivers' response styles. Another possibility is that the time periods sampled are too early to appreciate differences in skill development due to gestational age. Findings from this study support further validation of the SSIP scale of PediaTrac to understand its potential as a measure of emerging social attention and further supports investigation of caregiver report as a tool for understanding aspects of development, including social attention and communication, from the first days of life.

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Supplemental Tables

Supplemental Table 1

SSIP Newborn Predicting CSBS Social at 6 Months

		95% CI					
	B	*LL*	*UL*	*SE*	*β*	R^2	ΔR^2
Step 1						.033**	.033**
Constant	11.01***	7.37	14.65	1.85			
Infant sex	.25	-.46	.95	.36	.03		
Maternal education	.35***	-.53	-.17	.09	-.18***		
Gestational age	.03	-.07	.13	.05	.03		
Step 2						.05**	.017**
Constant	6.89**	2.26	11.52	2.36			
Infant sex	0.25	-.45	.95	.36	.03		
Maternal education	-.26**	-.45	-.07	.10	-.14**		
Gestational age	.04	-.06	.13	.05	.04		
SSIP newborn	.16**	.05	.26	.06	.14**		

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$

Supplemental Table 2

SSIP 2-Month Predicting CSBS Social at 6 Months

		95% CI					
	B	*LL*	*UL*	*SE*	*β*	R^2	ΔR^2
Step 1						.036*	.036*
Constant	11.96***	8.36	15.56	1.83			
Infant sex	.22	-.48	.91	.35	.03		
Maternal education	-.36***	-.54	-.18	.09	-.19***		
Gestational age	.002	-.09	.10	.05	.002		
Step 2						.046*	.011*
Constant	8.22***	3.36	13.09	2.48			
Infant sex	.19	-.50	.88	.35	.03		
Maternal education	-.31***	-.50	-.13	.09	-.16***		
Gestational age	.01	-.09	.10	.05	.01		
SSIP 2 month	.15*	.02	.28	.07	.11*		

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$

Supplemental Table 3

SSIP Newborn Predicting CSBS Symbolic at 6 Months

		95% CI					
	B	*LL*	*UL*	*SE*	*β*	*R2*	*ΔR2*
Step 1						.027**	.027**
Constant	9.74***	6.57	12.92	1.62			
Infant sex	.36	-.26	.97	.31	.05		
Maternal education	-.26**	-.41	-.10	.08	-.15**		
Gestational age	.05	-.04	.13	.04	.05		
Step 2						.051**	.024**
Constant	5.52**	1.5	9.54	2.05			
Infant sex	.37	-.24	.98	.31	.06		
Maternal education	-.17*	-.33	-.01	.08	-.10*		
Gestational age	.05	-.03	.14	.04	.06		
SSIP newborn	.16**	-.07	.25	.05	.16**		

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

Supplemental Table 4

SSIP 2-Month Predicting CSBS Symbolic at 6 Months

	B	95% CI *LL*	95% CI *UL*	*SE*	*β*	*R2*	*ΔR2*
Step 1						.031**	.031**
Constant	8.74***	5.53	11.94	1.63			
Infant sex	.31	-.31	.92	.31	.05		
Maternal education	-.27**	-.42	-.11	.08	-.16		
Gestational age	.07	-.02	.16	.04	.08		
Step 2						.046**	.015**
Constant	4.79*	.46	9.12	2.20			
Infant sex	.28	-.34	.89	.31	.04		
Maternal education	-.22**	-.38	-.06	.08	-.13**		
Gestational age	.07	-.01	.16	.04	.08		
SSIP 2 month	.16**	.04	.27	.06	.13**		

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$

Supplemental Table 5

SSIP Newborn Predicting CSBS Total at 6 Months

		95% CI					
	B	*LL*	*UL*	*SE*	*β*	*R2*	*ΔR2*
Step 1						.044***	.044***
Constant	99.59***	81.59	117.59	9.16			
Infant sex	.22	-3.27	3.70	1.78	.01		
Maternal education	-1.97***	-2.87	-1.08	.45	-.21***		
Gestational age	.29	-.19	.78	.25	.06		
Step 2						.067**	.023**
Constant	76.14***	53.36	98.91	11.59			
Infant sex	.29	-3.16	3.73	1.75	.01		
Maternal education	-1.50**	-2.43	-.57	.47	-.16**		
Gestational age	.34	-.14	.82	.24	.07		
SSIP newborn	.88**	.35	1.42	.27	.16**		

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

*$p < .05$. **$p < .01$. ***$p < .001$

Supplemental Table 6

SSIP 2-Month Predicting CSBS Total at 6 Months

		95% CI					
	B	*LL*	*UL*	*SE*	*β*	*R2*	*ΔR2*
Step 1						.046***	.046***
Constant	100.02***	81.98	118.07	9.18			
Infant sex	.46	-3.00	3.92	1.76	.01		
Maternal education	-2.03***	-2.91	-1.15	.45	-.21***		
Gestational age	.26	-.22	.75	.25	.05		
Step 2						.06*	.013*
Constant	79.09***	54.78	103.39	12.37			
Infant sex	.31	-3.13	3.75	1.75	.01		
Maternal education	-1.77***	-2.67	-.86	.46	-.18***		
Gestational age	.28	-.20	.76	.24	.05		
SSIP 2 month	.83*	.18	1.49	.33	.12*		

Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

*$p < .05$. **$p < .01$. ***$p < .001$

Supplemental Table 7

SSIP Newborn Predicting IBQ-R SF at 6 Months

	B	95% CI		*SE*	*β*	*R2*	*ΔR2*
		LL	*UL*				
Step 1						.03**	.03**
Constant	5.46***	4.89	6.03	.29			
Infant sex	.06	-.06	.17	.06	.05		
Maternal education	-.05***	-.08	-.02	.02	-.17***		
Gestational age	.01	-.01	.02	.01	.04		
Step 2						.10***	.069***
Constant	4.10****	3.38	4.81	.36			
Infant sex	.06	-.05	.17	.06	.05		
Maternal education	-.03	-.06	.004	.02	-.08		
Gestational age	.01	-.01	.02	.01	.05		
SSIP newborn	.05***	.03	.07	.01	.28***		

Note. IBQ-R SF = Infant Behavior Questionnaire- Revised Short Form. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

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

Supplemental Table 8

SSIP 2-Month Predicting IBQ-R SF at 6 Months

		95% CI					
	B	*LL*	*UL*	*SE*	*β*	*R2*	*ΔR2*
Step 1						.032**	.032**
Constant	5.42***	4.85	5.99	.29			
Infant sex	.05	-.07	.16	.06	.04		
Maternal education	-.05***	-.08	-.03	.02	-.17***		
Gestational age	.01	-.01	.02	.01	.04		
Step 2						.107***	.075***
Constant	3.80***	3.05	4.55	.38			
Infant sex	.04	-.07	.14	.06	.03		
Maternal education	-.03*	-.06	-.01	.01	-.11*		
Gestational age	.01	-.01	.02	.01	.05		
SSIP 2 month	.07***	.04	.09	.01	.28***		

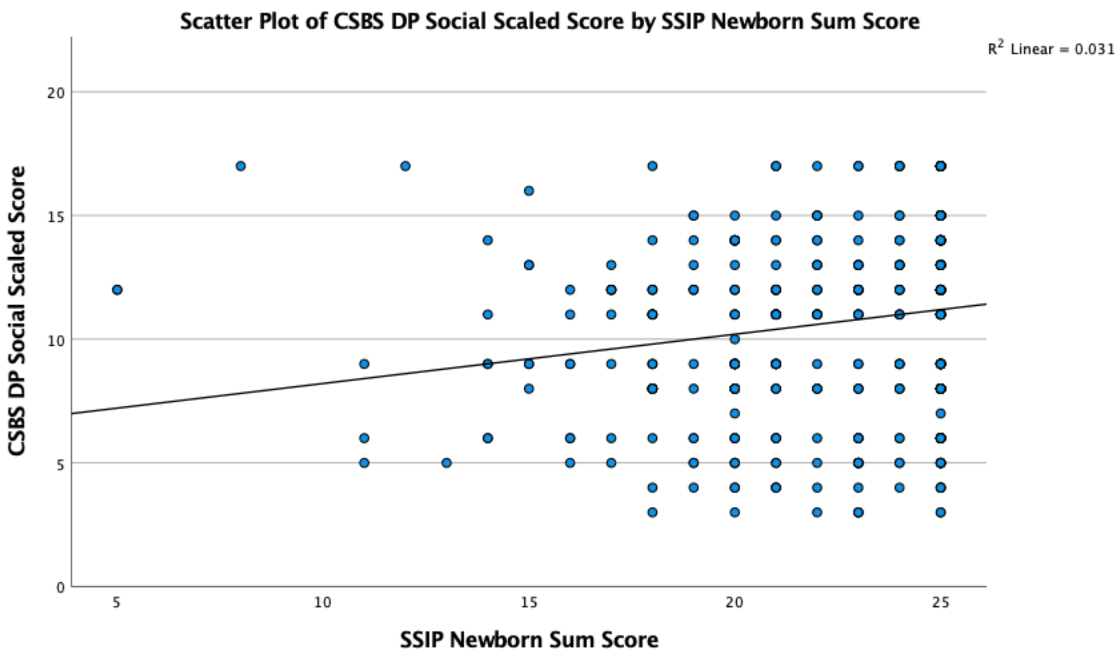
Note. IBQ-R SF = Infant Behavior Questionnaire- Revised Short Form. SSIP = Social Sensory Information Processing. CI = confidence interval; *LL* = lower limit; *UL* = upper limit.

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

Supplemental Figures

Supplemental Figure 1

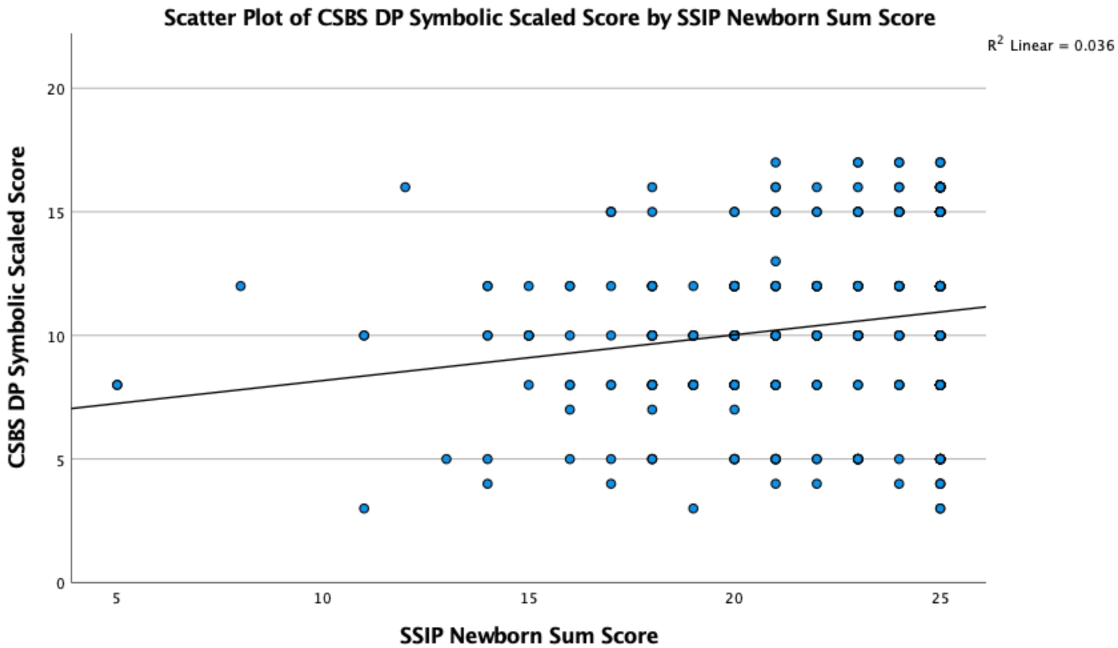
Scatter Plot of CSBS DP Social by SSIP Newborn



Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing.

Supplemental Figure 2

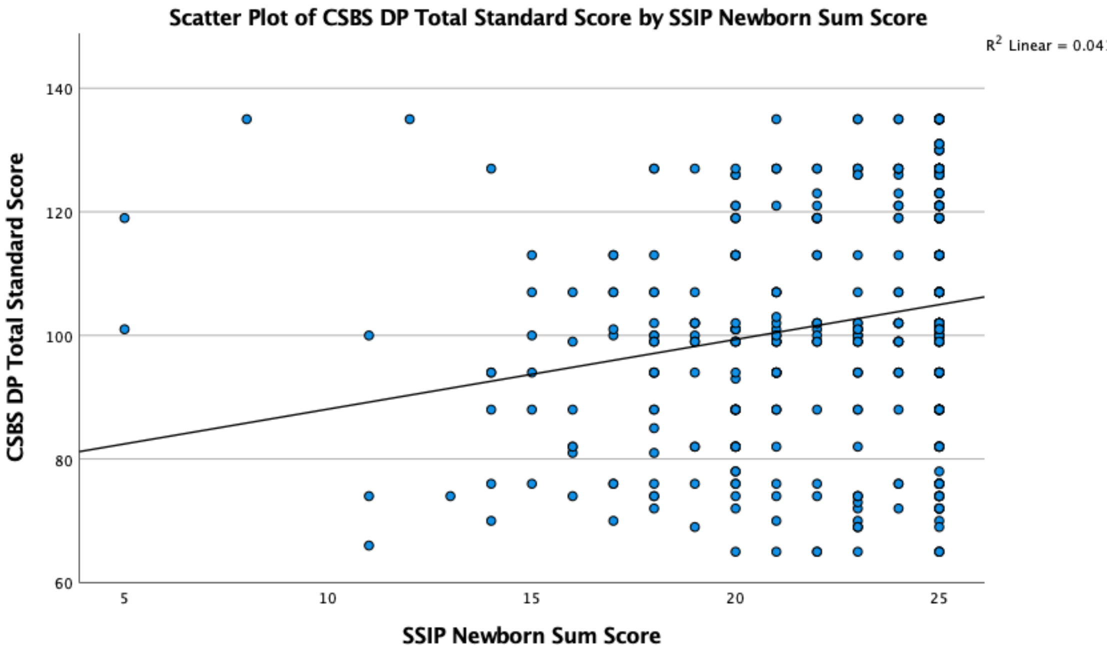
Scatter Plot of CSBS DP Symbolic by SSIP Newborn



Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing.

Supplemental Figure 3

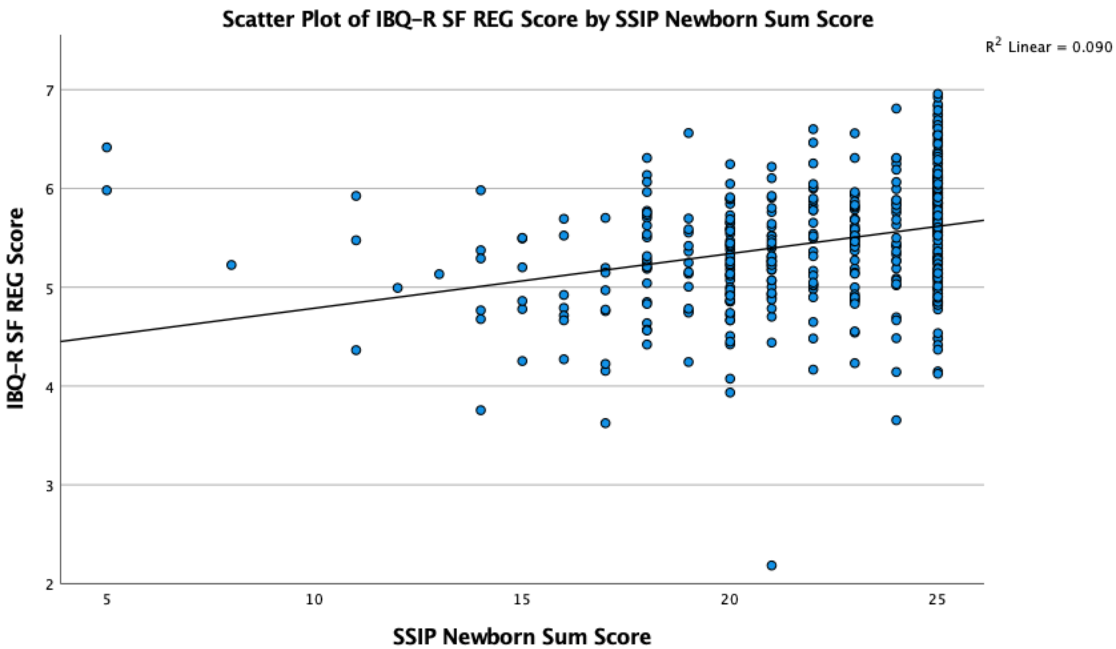
Scatter Plot of CSBS DP Total by SSIP Newborn



Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing.

Supplemental Figure 4

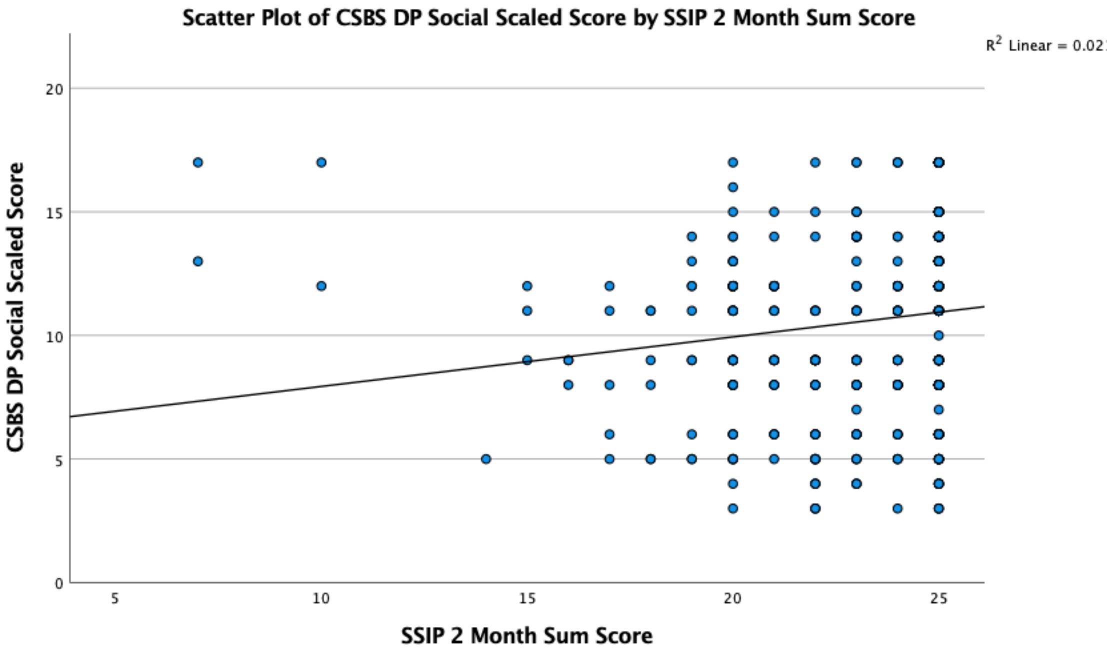
Scatter Plot of IBQ-R SF REG by SSIP Newborn



Note. IBQ-R SF = Infant Behavior Questionnaire- Revised Short Form. SSIP = Social Sensory Information Processing.

Supplemental Figure 5

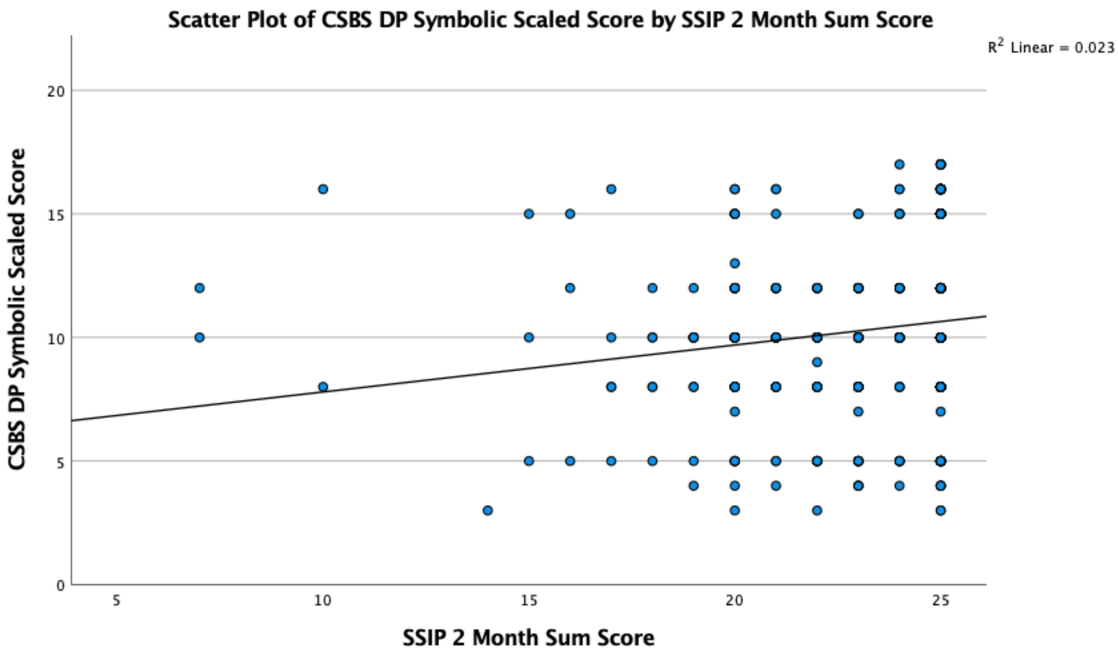
Scatter Plot of CSBS DP Social by SSIP 2-Month



Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing.

Supplemental Figure 6

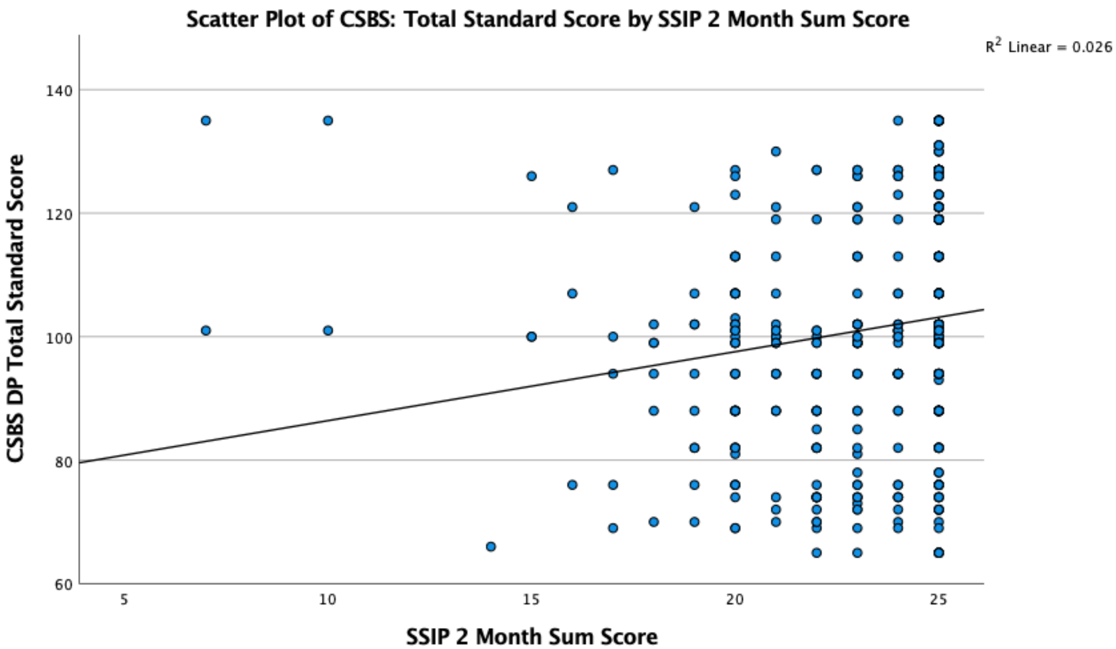
Scatter Plot of CSBS DP Symbolic by SSIP 2-Month



Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing.

Supplemental Figure 7

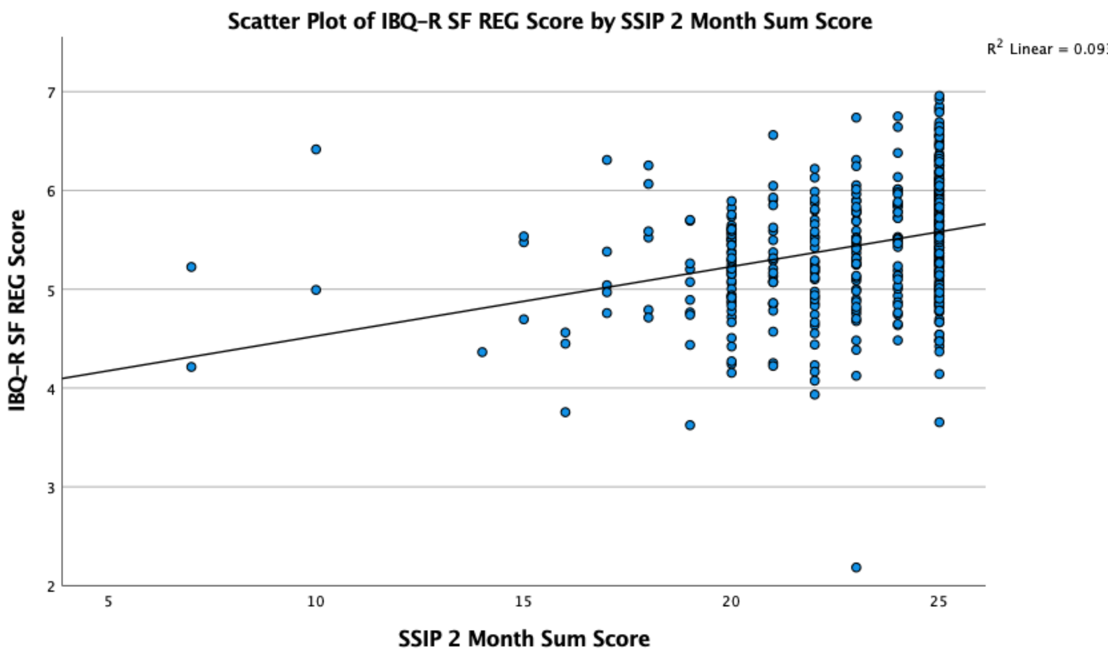
Scatter Plot of CSBS Total by SSIP 2-Month



Note. CSBS = The Communication and Symbolic Behavior Scales Developmental Profile. SSIP = Social Sensory Information Processing.

Supplemental Figure 8

Scatter Plot of IBQ-R SF REG by SSIP 2-Month



Note. IBQ-R SF = Infant Behavior Questionnaire- Revised Short Form. SSIP = Social Sensory Information Processing.

APPENDICES

Appendix A: Informational Flyer for Caregivers

PediaTrac™

For Parents

Something Exciting is Coming to Beaumont Pediatrics, University of Michigan/Michigan Medicine, and University Hospitals Cleveland Medical Center/Rainbow Babies & Children's Hospital.

We need to develop better ways to measure and track infant/toddler development so that we can spot potential problems in the first year of life, in order to address needs in a timely manner.

A team of scientists from **Eastern Michigan University, Beaumont Pediatrics, University of Michigan/Michigan Medicine, and University Hospitals Cleveland Medical Center/Rainbow Babies & Children's Hospital** is developing a web-based measure called Pediatrac™ designed for parents to keep track of your infant's development over time. Collecting information about your child's feeding/eating, sleep, physical skills, social development, communication and attachment will help us to identify factors that lead to optimal or problematic development.

If you'd like to help improve our understanding of infant development, please let us know.

_____Yes, I'd like to participate.
_____No, I'm not interested.
_____I'm not sure; please give me more information.

Caregiver name: ____
Phone number: ____
Email address: ____
Best time to reach me: ____

Appendix B: Study Information and Consent Form

EASTERN MICHIGAN UNIVERSITY

Study Information and Consent Form

Study Title: *PediaTrac™: Web-based Measure to Screen and Track Early Developmental Trajectories*

Company or agency sponsoring the study: Eunice Kennedy Shriver National Institute of Child Health & Human Development of the National Institutes of Health.

Principal Investigators:
Renee Lajiness-O'Neill, PhD (Project Director/PI), Eastern Michigan University (EMU)
Seth Warschausky, PhD (Site PI), University of Michigan (UM)
Alissa Huth-Bocks, PhD (Site PI), University Hospitals/Case Western Reserve University (UH/CWRU) Cleveland Medical Center/Rainbow Babies & Children's Hospital
H. Gerry Taylor (Site PI), Nationwide Children's Hospital

Location:
Eastern Michigan University (in collaboration with Beaumont Pediatrics), University of Michigan/Michigan Medicine, University Hospitals/Case Western Reserve University/Cleveland Medical Center/Rainbow Babies & Children's Hospital and Beaumont Pediatrics.

Key Study Information
You and your child, may be eligible to take part in a research study. This form contains information that will help you decide whether to join the study. All of the information in this form is important. Take time to carefully review this information. After you finish, you should talk to the researchers about the study and ask them any questions you have. If you decide to take part in the study, you will be asked to sign this form. Before you do, be sure you understand what the study is about.

A research study is different from the regular medical care you receive from your doctor. Research studies hope to make discoveries and learn new information about diseases and how to treat them. You should consider the reasons why you might want to join a research study or why it is not the best decision for you at this time.

Research studies do not always offer the possibility of treating disease or conditions. Research studies also have different kinds of risks and risk levels, depending on the type of the study. You may also need to think about other requirements for being in the study. For example, some studies require you to travel, though that is not the case in this instance. In your decision to participate in this study, consider all of these matters carefully.

This research collects health-related information to better understand infant and toddler development. This research is being conducted to develop a measure of infant/toddler development that relies on parent report and observations. As discussed below you will be asked to answer questions about your child's development and your own adjustment over your child's first 18-24 months of life.

There can be risks associated with joining any research study. The type of risk may impact whether you decide to join the study. For this study, some of these risks may include breach of confidentiality, though we have many strategies in place to protect your privacy. More detailed information will be provided later in this document.

This study may not offer any benefit to you now but may benefit others in the future by helping to identify if a child is showing a developmental lag that should be reviewed by their physician. More information will be provided later in this document.

As described below, we expect the amount of time you will participate in the study will be the first 18 months of your child's life, with possible invitation to participate in a final assessment at 2 years of age.

You can decide not to be in this study and there are no negative consequences for you or your child.

Even if you decide to join the study now, you are free to leave at any time if you change your mind.

Purpose:
You are being asked to be in this research study because you are a caregiver of a newborn infant. The goal of this project is to develop a better way to measure and track infant/toddler development so that pediatric providers can spot potential problems in the first years of life, in order to address children's developmental needs in a timely manner. The measure we are studying is called the PediaTrac™. Renee Lajiness-O'Neill holds a trademark for the PediaTrac tool. This study is being conducted at **Eastern Michigan University, University of Michigan/Michigan Medicine, University Hospitals/Case Western Reserve University/Cleveland Medical Center/Rainbow Babies & Children's Hospital.**

Study Procedures:
If you take part in the study, you will be asked to complete the PediaTrac™ questionnaire after the birth of your infant and when your infant is two (2), four (4), six (6), nine (9), twelve (12), fifteen (15), and eighteen (18) months old, using your computer, tablet or smart phone. For PediaTrac™, you will answer about ~50 questions at each time point about your child's feeding/eating, sleep, physical skills, social development, and language. In addition, you will be asked questions about your family background, your living environment, and medical issues. You will also be asked to complete other questionnaires at these same times using a pencil and paper format and possible other options. Access to PediaTrac™ will be provided directly to you with a link to the survey at each of the study time points. Other questionnaires will be mailed to your home in a binder that includes instructions as well as ways to contact us with questions. We will provide you with self-addressed stamped envelopes to send the paper questionnaires back. If this is not feasible or convenient for you, we will meet you in person at an agreed-upon location to assist you with completing the surveys. Friendly reminder phone calls, texts, or email will occur about 1 and 2 weeks before each month when we ask you to complete PediaTrac™ and the additional questionnaires. Three more in-depth contacts (e.g., phone, Skype, or Google Hangout) will be conducted at 6, 12, and 18 months to further assist you with completing the questionnaires, answer any questions you may have and support your participation in the study.

We will recruit some participants (about 10%) enrolled at UM and UH/CWRU to complete the PediaTrac measure and an additional measure of child development (Ages & Stages) using a research provided iPad at their pediatrician's office following the same schedule as their well-child visits (two (2), four (4), six (6), nine (9), twelve (12), fifteen (15), and eighteen (18) months) to evaluate how well PediaTrac could work in the real-world. All of the other pencil and paper measures would be mailed to your home and the procedures would be the same as those described above. At enrollment, you will be offered the opportunity to be entered into a pool from which we will randomly select participants who complete the measures using the iPad. You will consent to having your assigned RA meet you at your well-child visits throughout the duration of the study to help you use the iPad and support you in the process.

At 24-months of age, a smaller group of the participants will be asked to bring their child to the study clinic for a developmental assessment. Toddlers from Beaumont Pediatrics will complete these assessments in the EMU Psychology Clinic under the direction of the Project Director/PI, Dr. Lajiness-O'Neill. Toddlers from UM will complete these evaluations in the Neurodevelopmental Assessment Clinic in the Department of Physical Medicine and Rehabilitation under the direction of Site PI, Dr. Seth Warschausky. Toddlers at UH/CWRU will complete these assessments in the Department of Pediatrics under the direction of Site PI, Dr. Alissa Huth-Bocks, in collaboration with Dr. Gerry Taylor. The reason for doing this additional evaluation is to assess how well parent-completed PediaTrac™ compares to existing tools in predicting a child's development. This assessment will take about one (1) hour to complete.

The questions asked in the study will be about your infant's growth and development from birth through 18 months as well as questions about yourself and your family. You may choose not to answer some of the questions and still remain in the study. The total time to complete PediaTrac™ and the other questionnaires at each time period is about sixty (60) minutes when your baby is young and about 2 hours (120 minutes) when they are over 6 months of age. The phone calls will take approximately five (5) to ten (10) minutes depending on the questions you may have. It will take approximately one (1) hour if you participate in the follow-up assessment at 24 months. The questionnaires that we would like you to complete and the total time required are noted in the table at the end of this document.

Benefits:
As a participant in this research study, there may be no direct benefits to you; however, you may enjoy thinking about and reporting on your infant's development during the first few years of his/her life. Information from this study may also benefit children in the future. Your participation may help health care providers and researchers find a better and/or earlier way of predicting and diagnosing neurodevelopmental disorders or psychiatric illness in young children. Your participation will also help us validate the new PediaTrac™ tool as a new method to identify risk for developmental problems and delays. Participants in the 24-month follow up may benefit from receiving a report about their toddler's development, and those who may need other sources of assistance will benefit from receiving specialized referrals as needed.

Risks:
A rare risk of this study is the loss of confidentiality. We are very concerned about your privacy and have several safeguards in place to maintain the security of the surveys and your information are noted below.

You may also experience fatigue and frustration during this study as a result of answering the questionnaires. We may also identify a concern about your infant/toddler or you based on your responses to some of the questionnaires.

The researchers will try to minimize these risks by:
Burden or Stress. If you experience significant stress by the demands of participating in the study, you can stop the project at any time and there will not be any consequences.

Health Concern. If a concern about you or your infant's health becomes evident during the course of the study, the Principal Investigator (PI) will send you a letter and make phone contact with you to recommend that you consult with your child's pediatrician or a physician. Healthcare referrals will be made when necessary (e.g. if you do not have a regular healthcare provider).

If your response to some of our questionnaires indicates that you may be experiencing a health-related concern, the PI will contact you and provide you with resources for local mental health services. If imminent risk is suspected (e.g., hurting yourself or someone else), the PI or Site PI (all licensed psychologists) will contact you immediately to further assess for safety, refer you to specific follow-up providers, and implement emergency interventions if necessary such as assisting with connecting you to a psychiatric emergency room and/or calling the local police.

Costs:
There will be no costs to you for participating in this research study.

Compensation:
As a participant in this study you will compensated for your time and travel. After completing PediaTrac™ and the other surveys in each study month period, you will receive a gift card or cash in the following amount:
Birth: $20
2 months: $40
4 months: $40
6 months: $40
9 months: $40
12 months: $40
15 months: $40
18 months: $50
24 months: $100 (if part of the 24-month follow up)
Each gift card will be mailed to your home after the questionnaires are completed or given to you.

Confidentiality:
All information collected from you will be kept confidential. You will be identified in the research study by a code name. Your code name links your identity only for communication purposes between you and the researchers. We will collect your name, phone number, mailing address and email address to contact you only during the study and will keep this information separate from your responses on questionnaires and surveys. Your infant's participation in this study is also kept completely confidential; any paperwork containing your name or other identifying information is stored in locked cabinets in locked offices, with access limited to the study team.

Although we assure you that everything you tell us will remain confidential, there are some circumstances where the law requires that we may need to break this assurance in order to prevent somebody from getting hurt. For example, if you tell us something that leads us to believe that harm may come to somebody in the future, e.g. ongoing abuse of a minor or vulnerable adult, then we may need to alert proper authorities. If you tell us or we learn something that makes us believe that your child or others have been or may be physically harmed, we may be required to report that information to the appropriate agencies. If you tell us or we learn something that makes us believe you are at risk of hurting yourself, we may be required to report that information to the appropriate agencies. The

Principal Investigators are all licensed psychologists and mandatory reporters. Furthermore, all study staff are trained in the proper handling and storage of confidential information and study records.

This research is covered by a Certificate of Confidentiality from the National Institutes of Health. The researchers with this Certificate may not disclose or use information that may identify you in any federal, state, or local civil, criminal, administrative, legislative, or other action, suit, or proceeding, or be used as evidence, for example, if there is a court subpoena, unless you have consented for this use. Information protected by this Certificate cannot be disclosed to anyone else who is not connected with the research except, if there is a federal, state, or local law that requires disclosure (such as to report child abuse or communicable diseases but not for federal, state, or local civil, criminal, administrative, legislative, or other proceedings, see below); if you have consented to the disclosure, including for your medical treatment; or if it is used for other scientific research, as allowed by federal regulations protecting research subjects.

The Certificate cannot be used to refuse a request for information from personnel of the United States federal or state government agency sponsoring the project that is needed for auditing or program evaluation by the national Institutes of Health which is funding this project. You should understand that a Certificate of Confidentiality does not prevent you from voluntarily releasing information about yourself or your involvement in this research. If you want your research information released to an insurer, medical care provider, or any other person not connected with the research, you must provide consent to allow the researchers to release it.

The Certificate of Confidentiality will not be used to prevent disclosure as required by federal, state, or local law of in cases of suspected child abuse and neglect, or intent to harm to self or others.

Coded data collected during this study will be shared with and become part of the National Database for Autism Research (NDAR). A coded database from this study will be housed at EMU in a secure REDCap database.

With appropriate permissions collected information may also be shared with other researchers here, around the world, and with companies. Your identifiable private information may be stripped of identifiers and used for future research studies or distributed to another researcher for future research studies without additional informed consent. Research can lead to new discoveries, such as new tests, drugs, or devices. Researchers, their organizations, and other entities, including companies, may potentially benefit from the use of the data or discoveries. You will not have rights to these discoveries or any proceeds from them.

Medical information and billing records are protected by the privacy regulations of the federal Health Insurance Portability and Accountability Act of 1996 (HIPAA). This type of information is called protected health information (PHI). PHI about you may be obtained from any hospital, doctor, and other health care provider involved in your care, including:

- Hospital/doctor's office records, including test results (X-rays, blood tests, urine tests, etc.)
- Demographic information
- Personal identifiers
- Other information

There are many reasons why information about you may be used or seen by the researchers or others during or after this study. Examples include:

- The researchers may need the information to make sure you can take part in the study.
- University, FDA, or government auditors, and/or the IRB may need the information to make sure that the study is done in a safe and proper manner. Study sponsors or funders, or safety monitors or committees, may need the information to:
  - Make sure the study is done safely and properly
  - Analyze the results of the study
- Federal or State law may require the study team to give information to government agencies. For example, to prevent harm to you or others, or for public health reasons.
- HIPAA authorization for access to Protected Health Information (PHI) will be requested for some participants following the consent process.

As a rule, the researchers will not continue to use or disclose information about you, but will keep it secure until it is destroyed. Sometimes, it may be necessary for information about you to continue to be used or disclosed, even after you have canceled your permission or the study is over. Examples of reasons for this include:

- To avoid losing study results that have already included your information
- To provide limited information for research, education, or other activities. (This information would not include your name, social security number, or anything else that could let others know who you are.)
- To help University and government officials make sure that the study was conducted properly.

Your permission expires at the end of the study, unless you cancel it sooner. You may cancel your permission at any time by writing to the researchers listed in "Questions" (below). If you withdraw your permission, you may no longer be eligible to participate in this study.

HIPAA authorization for access to Protected Health Information (PHI) will be requested for some participants following the consent process.

The results of this study could be published in an article, but would not include any information that would let others know who you are.

Voluntary Participation/Withdrawal:
Taking part in this study is completely voluntary. You may choose not to take part in this study, or if you decide to take part, you can change your mind later and withdraw from the study. Your decision will not change any present or future relationships with any of the participating institutions. If you are employed by any of the participating institutions as an employee, your participation is completely voluntary and will not impact your job in any way.

Questions:
If you have any questions about this study now or in the future, or to talk about any problems you may have as a study subject, you may contact one of the members of the research team at the following phone numbers:

Renee Lajiness-O'Neill, PhD, Professor (EMU for Beaumont participants) – 734-487-0112
Seth Warschausky, PhD, Professor (For University of Michigan participants) – 734-232-1198
Alissa Huth-Bocks, PhD, Professor (For University Hospitals Cleveland Medical Center/Case Western Reserve University (UH/CWRU)/Rainbow Babies & Children's Hospital participants) – 216-983-1106.

You may also express a question or concern about a study by contacting the Institutional Review Board listed below:

University of Michigan Medical School Institutional Review Board (IRBMED)
2800 Plymouth Road
Building 520, Room 3214
Ann Arbor, MI 48109-2800
Telephone: 734-763-4768 (For International Studies, include the appropriate calling codes.)
Fax: 734-763-1234
e-mail: irbmed@umich.edu

Participation:
By completing PediaTrac™ and additional surveys, the phone interviews, and the visit to our study offices for the 24 months developmental assessment, you are agreeing to participate in this study.

Developmental, Behavioral, and Caregiver Self-Report Measures

MEASURES AND SAMPLING PERIODS	Birth	2 mos.	4 mos.	6 mos. (Skype)	9 mos.	12 mos. (Skype)	15 mos.	18 mos. (Skype)	24 mos. (Follow up N=100)
PediaTrac™	X	X	X	X	X	X	X	X	
Standardized Pediatric Developmental and Behavioral Questionnaires									
Infant Behavior Questionnaire-Revised (IBQ-R)			X	X	X	X	X	X	
Brief Infant Sleep Questionnaire (BISQ)	X		X		X		X		
Brief Infant-Toddler Social-Emotional Assessment (BITSEA)						X	X	X	
Ages & Stages Questionnaire-3 (ASQ-3)		X	X	X	X	X		X	
Communication and Symbolic Behavior Scales-Developmental Profile (CSBS-DP) Infant-Toddler Checklist				X	X	X	X	X	
M-CHAT-R/F								X	X
Bayley Scales of Infant and Toddler Developmental-III (Bayley-III)									X
Adaptive Behavior Assessment System-3 (ABAS-3)									X
Standardized Caregiver/Parenting and Mental Health Questionnaires									

Edinburgh Postnatal Depression Scale (EPDS)		X	X						
Brief Symptom Inventory (BSI)				X	X	X	X	X	
Postpartum Bonding Questionnaire (PBQ)	X	X							
Parenting Stress Index-4-Short Form (PSI-4-SF)				X		X		X	
Maternal Self-Report Inventory-Short Form (MSI-SF)	X	X							
Caregiver Response Bias									
Inventory of Problems (IOP-29) and PediaTrac-42		X				X			
Total Time per Sampling Period	60	60	90	120	120	120	120	120	60

Appendix C: PediaTrac Sensory Information Processing Questions

Item # (PediaTrac v2.0)	Item
	Who calms your infant by how they touch the infant?-Daycare Provider
	Who calms your infant by how they touch the infant?-Grandparent(s)
	Who calms your infant by how they touch the infant?-Other
	Who calms your infant by how they touch the infant?-Parenting Partner
	Who calms your infant by how they touch the infant?-Self
	Who calms your infant by how they touch the infant?-Sibling(s)
Q92_5	Who can calm your infant by picking up or holding them?-Daycare Provider
Q92_4	Who can calm your infant by picking up or holding them?-Grandparent(s)
Q92_6	Who can calm your infant by picking up or holding them?-other
Q92_2	Who can calm your infant by picking up or holding them?-Parenting Partner
Q92_1	Who can calm your infant by picking up or holding them?-Self
Q92_3	Who can calm your infant by picking up or holding them?-Sibling(s)
Q01_5	Whose voice calms your infant?-Daycare Provider
Q91_4	Whose voice calms your infant?-Grandparent(s)
Q91_6	Whose voice calms your infant?-Other
Q91_2	Whose voice calms your infant?-Parenting Partner
Q91_1	Whose voice calms your infant?-Self
Q91_3	Whose voice calms your infant?-Sibling(s)
Q09_5	Whose voice causes your infant to make eye contact?-Daycare Provider
Q90_4	Whose voice causes your infant to make eye contact?-Grandparent(s)
Q90_6	Whose voice causes your infant to make eye contact?-other
Q90_2	Whose voice causes your infant to make eye contact?-Parenting Partner
Q90_1	Whose voice causes your infant to make eye contact?-Self
Q90_3	Whose voice causes your infant to make eye contact?-Sibling(s)
Q89_5	With whom does your infant make eye contact?-Daycare Provider
Q89_4	With whom does your infant make eye contact?-Grandparent(s)
Q89_6	With whom does your infant make eye contact?-Other
Q89_2	With whom does your infant make eye contact?-Parenting Partner
Q89_1	With whom does your infant make eye contact?-Self

Q89_3	With whom does your infant make eye contact?-Sibling(s)

Appendix D: Infant Behavior Questionnaire-Revised Short Form

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Maria A. Gartstein
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Infant Behavior Questionnaire - Revised

Subject No. [redacted]

Today's Date [redacted]

Sex of Child [redacted]

Date of Baby's Birth [redacted]
month. day year

Age of Child [redacted]
mos. weeks

INSTRUCTIONS:
Please read carefully before starting:

As you read each description of the baby's behavior below, please indicate how often the baby did this during the LAST WEEK (the past seven days) by circling one of the numbers in the left column. These numbers indicate how often you observed the behavior described during the last week.

(1) Never	(2) Very Rarely	(3) Less Than Half the Time	(4) About Half the Time	(5) More Than Half the Time	(6) Almost Always	(7) Always	(X) Does Not Apply

The "Does Not Apply" (X) column is used when you did not see the baby in the situation described during the last week. For example, if the situation mentions the baby having to wait for food or liquids and there was no time during the last week when the baby had to wait, circle the (X) column. "Does Not Apply" is different from "Never" (1). "Never" is used when you saw the baby in the situation but the baby never engaged in the behavior listed during the last week. For example, if the baby did have to wait for food or liquids at least once but never cried loudly while waiting, circle the (1) column.

Please be sure to circle a number for <u>every</u> item.

(1) Never	(2) Very Rarely	(3) Less Than Half the Time	(4) About Half the Time	(5) More Than Half the Time	(6) Almost Always	(7) Always	(X) Does Not Apply

One Week Time Span

How often did your baby:

1 2 3 4 5 6 7 X . . . . (1) make talking sounds when s/he was ready for more food?

1 2 3 4 5 6 7 X . . . . (2) seem angry (crying and fussing) when you left her/him in the crib?

1 2 3 4 5 6 7 X . . . . (3) seem contented when left in the crib?

1 2 3 4 5 6 7 X . . . . (4) cry or fuss before going to sleep for naps?

1 2 3 4 5 6 7 X . . . . (5) look at pictures in books and/or magazines for 5 minutes or longer at a time?

1 2 3 4 5 6 7 X . . . . (6) stare at a mobile, crib bumper or picture for 5 minutes or longer?

1 2 3 4 5 6 7 X . . . . (7) play with one toy or object for 5-10 minutes?

1 2 3 4 5 6 7 X . . . . (8) play with one toy or object for 10 minutes or longer?

1 2 3 4 5 6 7 X . . . . (9) laugh aloud in play?

1 2 3 4 5 6 7 X . . . . (10) repeat the same movement with an object for 2 minutes or longer (e.g.,putting a block in a cup, kicking or hitting a mobile)?

1 2 3 4 5 6 7 X . . . . (11) smile or laugh after accomplishing something (e.g., stacking blocks, etc.)?

1 2 3 4 5 6 7 X . . . . (12) smile or laugh when given a toy?

1 2 3 4 5 6 7 X . . . . (13) enjoy being read to?

1 2 3 4 5 6 7 X . . . . (14) enjoy hearing the sound of words, as in nursery rhymes?

1 2 3 4 5 6 7 X . . . . (15) enjoy gentle rhythmic activities, such as rocking or swaying?

1 2 3 4 5 6 7 X . . . . (16) enjoy being tickled by you or someone else in your family?

1 2 3 4 5 6 7 X . . . . (17) enjoy the feel of soft blankets ?

1 2 3 4 5 6 7 X . . . . (18) enjoy being rolled up in a warm blanket?

(1) Never	(2) Very Rarely	(3) Less Than Half the Time	(4) About Half the Time	(5) More Than Half the Time	(6) Almost Always	(7) Always	(X) Does Not Apply

1 2 3 4 5 6 7 X . . . . (19) enjoy listening to a musical toy in a crib?

1 2 3 4 5 6 7 X . . . . (20) look up from playing when the telephone rang?

1 2 3 4 5 6 7 X . . . . (21) protest being placed in a confining place (infant seat, play pen, car seat, etc)?

1 2 3 4 5 6 7 X . . . . (22) startle at a sudden change in body position (for example, when moved suddenly)?

1 2 3 4 5 6 7 X . . . . (23) move quickly toward new objects?

1 2 3 4 5 6 7 X . . . . (24) show a strong desire for something s/he wanted?

1 2 3 4 5 6 7 X . . . . (25) watch adults performing household activities (e.g., cooking, etc.) for more than 5 minutes?

1 2 3 4 5 6 7 X . . . . (26) squeal or shout when excited?

1 2 3 4 5 6 7 X . . . . (27) notice low-pitched noises (e.g. air conditioner, heating system, or refrigerator running or starting up)?

1 2 3 4 5 6 7 X . . . . (28) notice a change in light when a cloud passed over the sun?

1 2 3 4 5 6 7 X . . . . (29) notice the sound of an airplane passing overhead?

1 2 3 4 5 6 7 X . . . . (30) notice a bird or a squirrel up in a tree?

1 2 3 4 5 6 7 X . . . . (31) notice fabrics with scratchy texture (e.g., wool)?

1 2 3 4 5 6 7 X . . . . (32) appear sad for no apparent reason?

<u>During feeding, how often did the baby:</u>

1 2 3 4 5 6 7 X . . . . (33) lie or sit quietly?

1 2 3 4 5 6 7 X . . . . (34) squirm or kick?

1 2 3 4 5 6 7 X . . . . (35) wave his/her arms?

(1) Never	(2) Very Rarely	(3) Less Than Half the Time	(4) About Half the Time	(5) More Than Half the Time	(6) Almost Always	(7) Always	(X) Does Not Apply

When going to sleep at night, how often did your baby:

1 2 3 4 5 6 7 X . . . . (36) fall asleep within 10 minutes?

1 2 3 4 5 6 7 X . . . . (37) have a hard time settling down to sleep?

1 2 3 4 5 6 7 X . . . . (38) settle down to sleep easily?

When being dressed or undressed during the last week, how often did the baby:

1 2 3 4 5 6 7 X . . . . (39) squirm and/or try to roll away?

1 2 3 4 5 6 7 X . . . . (40) smile or laugh?

1 2 3 4 5 6 7 X . . . . (41) coo or vocalize?

When put into the bath water, how often did the baby:

1 2 3 4 5 6 7 X . . . . (42) smile?

1 2 3 4 5 6 7 X . . . . (43) laugh?

When tossed around playfully how often did the baby:

1 2 3 4 5 6 7 X . . . . (44) smile?

1 2 3 4 5 6 7 X . . . . (45) laugh?

During a peekaboo game, how often did the baby:

1 2 3 4 5 6 7 X . . . . (46) smile?

1 2 3 4 5 6 7 X . . . . (47) laugh?

How often did your baby enjoy bouncing up and down:

1 2 3 4 5 6 7 X . . . . (48) while on your lap?

1 2 3 4 5 6 7 X . . . . (49) on an object, such as a bed, bouncer chair, or toy?

When being held, how often did the baby:

1 2 3 4 5 6 7 X . . . . (50) pull away or kick?

1 2 3 4 5 6 7 X . . . . (51) seem to enjoy him/herself?

(1) Never	(2) Very Rarely	(3) Less Than Half the Time	(4) About Half the Time	(5) More Than Half the Time	(6) Almost Always	(7) Always	(X) Does Not Apply

When the baby wanted something, how often did s/he:

1 2 3 4 5 6 7 X . . . . (52) become upset when s/he could not get what s/he wanted?

1 2 3 4 5 6 7 X . . . . (53) have tantrums (crying, screaming, face red, etc.) when s/he did not get what s/he wanted?

When placed in an infant seat or car seat, how often did the baby:

1 2 3 4 5 6 7 X . . . . (54) wave arms and kick?

1 2 3 4 5 6 7 X . . . . (55) squirm and turn body?

How often did your baby make talking sounds when:

1 2 3 4 5 6 7 X . . . . (56) riding in a car?

1 2 3 4 5 6 7 X . . . . (57) riding in a shopping cart?

1 2 3 4 5 6 7 X . . . . (58) you talked to her/him?

When rocked or hugged, in the last week, how often did your baby:

1 2 3 4 5 6 7 X . . . . (59) seem to enjoy her/himself?

1 2 3 4 5 6 7 X . . . . (60) seem eager to get away?

1 2 3 4 5 6 7 X . . . . (61) While being fed in your lap, how often did the baby seem eager to get away as soon as the feeding was over?

1 2 3 4 5 6 7 X . . . . (62) After sleeping, how often did the baby cry if someone didn't come within a few minutes?

1 2 3 4 5 6 7 X . . . . (63) When put down for a nap, how often did your baby settle down quickly?

1 2 3 4 5 6 7 X . . . . (64) When it was time for bed or a nap and your baby did not want to go, how often did s/he whimper or sob?

1 2 3 4 5 6 7 X . . . . (65) When face was washed, how often did the baby smile or laugh?

1 2 3 4 5 6 7 X . . . . (66) When hair was washed, how often did the baby vocalize?

1 2 3 4 5 6 7 X . . . . (67) When playing quietly with one of her/his favorite toys, how often did your baby enjoy lying in the crib for more than 5 minutes?

(1) Never	(2) Very Rarely	(3) Less Than Half the Time	(4) About Half the Time	(5) More Than Half the Time	(6) Almost Always	(7) Always	(X) Does Not Apply

1 2 3 4 5 6 7 X . . . . (68) When your baby saw a toy s/he wanted, how often did s/he get very excited about getting it?

1 2 3 4 5 6 7 X . . . . (69) When given a new toy, how often did your baby immediately go after it?

1 2 3 4 5 6 7 X . . . . (70) When placed on his/her back, how often did the baby squirm and/or turn body?

1 2 3 4 5 6 7 X . . . . (71) When frustrated with something, how often did your baby calm down within 5 minutes?

1 2 3 4 5 6 7 X . . . . (72) When your baby was upset about something, how often did s/he stay upset for up to 20 minutes or longer?

1 2 3 4 5 6 7 X . . . . (73) When being carried, how often did your baby push against you until put down?

1 2 3 4 5 6 7 X . . . . (74) When tired, how often did your baby show distress?

1 2 3 4 5 6 7 X . . . . (75) At the end of an exciting day, how often did your baby become tearful?

Two Week Time Span

When introduced to an unfamiliar adult, how often did the baby:

1 2 3 4 5 6 7 X . . . . (76) cling to a parent?

1 2 3 4 5 6 7 X . . . . (77) refuse to go to the unfamiliar person?

1 2 3 4 5 6 7 X . . . . (78) never "warm up" to the unfamiliar adult?

When you were busy with another activity and your baby was not able to get your attention, how often did s/he:

1 2 3 4 5 6 7 X . . . . (79) become sad?

1 2 3 4 5 6 7 X . . . . (80) cry?

When singing or talking to your baby, how often did s/he:

1 2 3 4 5 6 7 X . . . . (81) soothe immediately?

1 2 3 4 5 6 7 X . . . . (82) take more than 10 minutes to soothe?

(1) Never	(2) Very Rarely	(3) Less Than Half the Time	(4) About Half the Time	(5) More Than Half the Time	(6) Almost Always	(7) Always	(X) Does Not Apply

When showing the baby something to look at, how often did s/he:

1 2 3 4 5 6 7 X . . . . (83) soothe immediately?

1 2 3 4 5 6 7 X . . . . (84) take more than 10 minutes to soothe?

When patting or gently rubbing some part of the baby's body, how often did s/he:

1 2 3 4 5 6 7 X . . . . (85) soothe immediately?

1 2 3 4 5 6 7 X . . . . (86) take more than 10 minutes to soothe?

1 2 3 4 5 6 7 X . . . . (87) When in the presence of several unfamiliar adults, how often did the baby continue to be upset for 10 minutes or longer?

1 2 3 4 5 6 7 X . . . . (88) When visiting a new place, how often did the baby get excited about exploring new surroundings?

1 2 3 4 5 6 7 X . . . . (89) When an unfamiliar adult came to your home or apartment, how often did your baby cry when the visitor attempted to pick her/him up?

1 2 3 4 5 6 7 X . . . . (90) When familiar relatives/friends came to visit, how often did your baby get excited?

1 2 3 4 5 6 7 X . . . . (91) When rocking your baby, how often did s/he take more than 10 minutes to soothe?

Appendix E: Communication and Symbolic Behavior Scales-Developmental Profile

CSBS DP

CSBS DP Infant-Toddler Checklist

Child's name: [redacted] *Date of birth:* [redacted] *Date filled out:* [redacted]

Was birth premature? [redacted] *If yes, how many weeks premature?* [redacted]

Filled out by: [redacted] *Relationship to child:* [redacted]

Instructions for caregivers: This Checklist is designed to identify different aspects of development in infants and toddlers. Many behaviors that develop before children talk may indicate whether or not a child will have difficulty learning to talk. This Checklist should be completed by a caregiver when the child is between **6 and 24 months of age** to determine whether a referral for an evaluation is needed. The caregiver may be either a parent or another person who nurtures the child daily. Please check all the choices that best describe your child's behavior. If you are not sure, please choose the closest response based on your experience. **Children at your child's age are not necessarily expected to use all the behaviors listed.**

Emotion and Eye Gaze

1. Do you know when your child is happy and when your child is upset? ☐ Not Yet ☐ Sometimes ☐ Often
2. When your child plays with toys, does he/she look at you to see if you are watching? ☐ Not Yet ☐ Sometimes ☐ Often
3. Does your child smile or laugh while looking at you? ☐ Not Yet ☐ Sometimes ☐ Often
4. When you look at and point to a toy across the room, does your child look at it? ☐ Not Yet ☐ Sometimes ☐ Often

Communication

5. Does your child let you know that he/she needs help or wants an object out of reach? ☐ Not Yet ☐ Sometimes ☐ Often
6. When you are not paying attention to your child, does he/she try to get your attention? ☐ Not Yet ☐ Sometimes ☐ Often
7. Does your child do things just to get you to laugh? ☐ Not Yet ☐ Sometimes ☐ Often
8. Does your child try to get you to notice interesting objects—just to get you to look at the objects, not to get you to do anything with them? ☐ Not Yet ☐ Sometimes ☐ Often

Gestures

9. Does your child pick up objects and give them to you? ☐ Not Yet ☐ Sometimes ☐ Often
10. Does your child show objects to you without giving you the object? ☐ Not Yet ☐ Sometimes ☐ Often
11. Does your child wave to greet people? ☐ Not Yet ☐ Sometimes ☐ Often
12. Does your child point to objects? ☐ Not Yet ☐ Sometimes ☐ Often
13. Does your child nod his/her head to indicate *yes*? ☐ Not Yet ☐ Sometimes ☐ Often

Sounds

14. Does your child use sounds or words to get attention or help? ☐ Not Yet ☐ Sometimes ☐ Often
15. Does your child string sounds together, such as *uh oh, mama, gaga, bye bye, bada*? ☐ Not Yet ☐ Sometimes ☐ Often
16. About how many of the following consonant sounds does your child use: *ma, na, ba, da, ga, wa, la, ya, sa, sha*? ☐ None ☐ 1–2 ☐ 3–4 ☐ 5–8 ☐ over 8

Words

17. About how many different words does your child use meaningfully that you recognize (such as *baba* for bottle; *gaggie* for doggie)? ☐ None ☐ 1–3 ☐ 4–10 ☐ 11–30 ☐ over 30
18. Does your child put two words together (for example, *more cookie, bye bye Daddy*)? ☐ Not Yet ☐ Sometimes ☐ Often

Understanding

19. When you call your child's name, does he/she respond by looking or turning toward you? ☐ Not Yet ☐ Sometimes ☐ Often
20. About how many different words or phrases does your child understand without gestures? For example, if you say "where's your tummy," "where's Daddy," "give me the ball," or "come here," without showing or pointing, your child will respond appropriately. ☐ None ☐ 1–3 ☐ 4–10 ☐ 11–30 ☐ over 30

Object Use

21. Does your child show interest in playing with a variety of objects? ☐ Not Yet ☐ Sometimes ☐ Often
22. About how many of the following objects does your child use appropriately: cup, bottle, bowl, spoon, comb or brush, toothbrush, washcloth, ball, toy vehicle, toy telephone? ☐ None ☐ 1–2 ☐ 3–4 ☐ 5–8 ☐ over 8
23. About how many blocks (or rings) does your child stack? **Stacks** ☐ None ☐ 2 blocks ☐ 3–4 blocks ☐ 5 or more
24. Does your child pretend to play with toys (for example, feed a stuffed animal, put a doll to sleep, put an animal figure in a vehicle)? ☐ Not Yet ☐ Sometimes ☐ Often

Do you have any concerns about your child's development? ☐ yes ☐ no If yes, please describe on back.

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