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Clinical Correlates of Social Affect in Early Infancy: Implications for Early Identification of Autism Spectrum Disorder

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by

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ABSTRACT

Clinical Correlates of Social Affect in Early Infancy: Implications for Early Identification of Autism Spectrum Disorder

by

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Earlier intervention for infants and toddlers with autism spectrum disorder (ASD) enhances developmental gains (Rogers, et al. 2012) and necessitates ascertainment of early, reliable indicators of ASD. Diminished social attention and positive social affect have been among the leading hypothesized risk factors for ASD in the prelinguistic period, between 6-12 months of age, however research has resulted in mixed findings for the predictive value of social engagement in 6-9-month-old infants for the development of ASD. If abnormalities in infant social affect contribute to the early phenotypic expression of ASD, it is important to determine whether diminished social affect is a unique construct associated exclusively with social impairments or if it is, alternatively, an expression of normal variation in individual development better explained by temperamental style. The current study sought to enhance the understanding of social development in early infancy by investigating individual differences in social engagement during face-to-face dyadic interactions. Expression of positive social affect during a structured dyadic parent-infant interaction was measured for 33 typically developing 6-8-month old infants. This measure was then correlated with concurrent clinical measures of social-communication, vocal production, autism symptomology, and temperament. Results revealed a positive

association between positive social affect and the receptive language component of social-communication. No significant relations were observed between positive social affect, vocal production, autism symptomology, or temperament. These results suggest that infant positive social during interaction with a caregiver is a reflection of some elements of social-communicative ability for 6-8 month old infants, but not temperamental style. Further research is needed to understand how diminished positive social affect in early infancy may impact later developmental outcomes. Implications for early identification of ASD and relevant intervention strategies are discussed.

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Introduction

Empirical and comprehensive understanding of typical development in early infancy is essential for research exploring prodromal risk markers associated with later developmental psychopathology. Early identification of disabilities that lack biomarkers or easily detectable behavioral indicators has significant implications for prevention and intervention research and clinical practice. Autism spectrum disorder (ASD) is one such neurodevelopmental disability that behaviorally manifests between the ages of 12-36 months. It is hypothesized to have both genetic and environmental components that interact in such a way to either suppress or incite the full-blown syndrome of ASD (Chaste & Leboyer, 2012). Infants and toddlers with ASD between 12-24 months of age present with dramatically different social-affective profiles compared to typically developing infants (Zwaigenbaum, Bryson, & Garon, 2013), yet social behavioral abnormalities have yet to be consistently identified in infants younger than 12 months.

Assessment of early behavioral patterns predictive of later clinically relevant symptoms of ASD is a complex and still growing area of research (Macari et al., 2012). In contrast, the study of social development in typical infants is a field rich with empirical evidence documenting the emergence of social attention, affective expression, communication, temperament styles, and the complex dynamics of dyadic parent-infant interactions. Despite the breadth of research detailing patterns of social development in typical infants 6-12 months, it is less understood how atypical behaviors may relate to concurrent and long-term developmental abnormalities. Identification of such aberrant behaviors may advance the understanding of early markers for social-communication difficulties and ASD. This research approach has successfully ascertained several early markers of ASD in infants between 12-24 months, including abnormalities in social

attention, social smiling, and social-communication, however the expression of these autism-specific abnormalities in infants under 12 months has proved more difficult to observe (see Zwaigenbaum, Bryson, & Garon, 2013 for a review). Among the most prominent of hypothesized early markers of ASD are decreased attention to social stimuli and lower frequencies of social smiling (Chawarska, Macari, & Shic, 2013; Klin & Jones, 2013; Maestro et al., 2005). In contrast it is important to distinguish between behavioral profiles that may indicate psychopathology, for example ASD, and those that represent normal individual variability in development, such as temperamental style. An understanding of how proposed early markers are uniquely related to clinically relevant behaviors, such as social-communicative abilities and autism symptoms, as well as how they are associated with typical individual variation, such as temperament, is one approach to distinguishing between early "red flags" for ASD and typical behavior.

Positive Social Affect

One of the earliest measures of social engagement in infancy is the observation of positive social affect, also termed social smiling. Social smiling is a developmental milestone that begins at around 2 months of age and by 6 months, infants are observed to consistently engage in mutually shared positive affect and reciprocal social smiling during dyadic interactions with adults (Parlade et al., 2009). Infants have been observed to smile for approximately 20% of dyadic interactions, a frequency that is stable from 2-6 months (Fogel et al., 2006; Malatesta et al., 1989; Messinger, 2008).

Several theories have been developed to speculate the origin and purpose of social smiling in preverbal infants. A cognitive/constructivist approach understands smiling as the product of a release of cognitive tension while processing visual stimuli. Smiling then increases as infants are better able to cognitively engage with the environment (Sroufe, 1995). A functional theory perspective hypothesizes that smiling is a product of goal

attainment, whether it be achievement of social or nonsocial interactions with the environment (Barret, 1993). Research has shown that smiling is also related to experiences of contingent social interactions (Watson, 1972) such that dynamic patterns of infant social smiling are transactional in nature and related to parent-provided stimulation and parent responsivity. It is through these reliable contingencies during social interactions that infants learn they have an effect on the environment (Ainsworth & Bell, 1974).

In order to distinguish the social and nonsocial mechanisms of interactive smiling, social smiling has been measured in relation to other social and nonsocial behaviors. This research has found social smiling to be significantly associated with other measures of social pleasure, such as smiling during social games, but not nonsocial pleasure, such as smiling in response to novel stimuli (Aksan & Kochanska, 2004). These authors conclude that infant smiling during social interactions is an indicator of social reward. The more integrative dynamic systems approach follows this line of research and adopts a more social than cognitive etiological explanation for social smiling in infancy. This theory claims that social smiling serves a communicative role in which enjoyment is expressed in order to continue an interaction, perhaps acting as an indicator of social motivation (Messinger & Fogel, 2007). This framework views social smiling as an emotional signal both to the self and the interactive partner. The communicative significance of social smiling grows as infants get older. Social smiling becomes more frequent between 3-9 months of age, suggesting it is a behavior associated with developmental maturity (Cohn and Tronick, 1987; Striano and Bertin, 2005; Yale, Messinger, Lewis, and Delgado, 2003). After about 9 months of age, young infants begin to develop intentional, nonverbal communication using integration of eye contact and gestures with social smiling.

Between 8-10 months of age, infants begin to exhibit anticipatory smiling, a behavior indicative of intentional affective sharing, i.e. social-communication. Anticipatory smiling is defined by the following sequence: (a) the infant gazes to an object, (b) the infant produces a smile, and (c) the infant turns to gaze at a social partner while smiling. Parlade et al. (2009) found that overall smiling at 6 months of age was related to anticipatory smiling at 8 and 10 months along with social expressiveness at 30 months, suggesting that smiling at 6 months of age may constitute a foundational skill for later developing social cognition. This study, however, did not investigate concurrent social-communicative correlates of smiling at 6 months of age and so it is unknown to what degree social smiling at an early age is related to social-cognitive skills. Striano, Stahl, and Cleveland (2009) contend that positive social affect (i.e., positive affect coordinated visual attention) is a specific type of behavior that indicates an infant's attempt to share information about the world exclusively for social purposes. In support of this hypothesis, Striano and Stahl (2005) found that infants smiled when an adult visually referenced another object (a bid for joint attention), whereas they did not smile when an adult simply looked away. In this case, smiling differentiated the infant's understanding of a social and nonsocial event. Additionally, infants exhibit more smiling when communicating in order to gain social reinforcement, such as commenting, showing, or sharing, but smile less frequently when communicating to gain tangible reinforcement, for example, requesting (Messinger, 2008). Jones and Hong (2001) reported evidence for anticipatory smiling as a precursor to communication with the finding that the development of anticipatory smiling and voluntary communicative behaviors were significantly related to each other between 8-12 months of age. Those infants who exhibited intentional attempts to communicate were significantly more likely to display anticipatory smiles. Research has also demonstrated that smiling is associated with

initiating joint attention, an important social-communicative skill and precursor to language, and that children with deficits in initiating joint attention correspondingly exhibited diminished positive affect (Kasari, Sigman, Mundy, & Yirmiya, 1990). Together this evidence suggests that social smiling serves a special communicative function early in life and could provide a measure of social motivation in early infancy.

Individual variability in infant smiling has been associated with cognitive, language, and temperamental differences. Smiling during dyadic parent-infant interactions was found to be associated with parent-reported positive affect during social activities (Bridges, Palmer, Morales, Hurtado, & Tsai, 1993), but not positive affect during nonsocial routines (Aksan & Kochanska, 2004). Further, overall positive affect exhibited during social interactions at 3 months was found to be significantly associated with language abilities at 2 years of age (Feldman & Greenbuam, 1997).

Infant smiling has also been associated with developmental disabilities (Messinger, 2008). Patterns of social smiling are atypical in infants at risk for developmental disabilities, including premature infants (Eckerman, Hsu, Molitor, Leung, and Goldstein, 1999), infants who are blind (Rogers and Puchalski, 1986), infants with Down syndrome (Carvajal and Iglesias, 2001), and infants with ASD (Ozonoff et al., 2010). Infants who are blind demonstrate social smiles in response to hearing social events, but smiles are less regularly elicited and more fleeting than those of sighted infants. This is thought to be caused by a lack of mutually reinforcing visual smiling exchanges. Infants with Down syndrome, the majority of whom also experience cognitive delays, exhibit an increased frequency of indiscriminate smiling; that is, they tend to smile equally to both people *and* objects whereas typically developing infants direct smiles almost exclusively to caregivers.

Research investigating differences in positive affect in infants with ASD has resulted in mixed findings. Maestro, et al. (2002) used retrospective home video tapes to identify fewer instances of social smiling in 6-month-old infants with ASD. Similarly, Clifford and Dissanayake (2008) also observed impaired quality of affect expression in young infants with ASD. Together, these findings suggest a nuanced abnormality in expression of affect during naturalistic parent-infant interactions in the very early development of ASD. However, these findings have not been replicated in prospective studies measuring social smiling using standardized paradigms. In fact, limited research on this topic has reported indistinguishable patterns of social smiling in 6-month-old infants with and without ASD (Ozonoff, et al., 2010; Zwaigenbaum et al., 2005). However, as infants develop and social demands increase in complexity, infants with ASD consistently express diminished positive affect during parent-infant interactions by the age of 12 months (Ozonoff, et al. 2010; Wan et al., 2012; Zwaigenbaum et al. 2005; Rozga et al., 2011). These data suggest a period between 6-12 months in which infants with ASD experience a rapid decline in the frequency of sharing positive affect with adults during social interactions. However, the underlying mechanisms and associated behavioral patterns that accompany attenuated social affect in the 6-12 month period are unclear.

Methodological disparities between studies investigating social affect in infants with ASD could, in part, account for contradictory results. For example, Maestro et al. (2002) and Werner, Dawson, Osterling, and Dinno (2000) utilized non-standardized home videotapes in which infants could be engaged in a wide range of behaviors in an array of settings with a caregiver. In contrast, Ozonoff et al. (2010) recorded displays of social smiles with an unfamiliar examiner during a standard developmental assessment. The lack of behavioral markers at 6 months reported by Zwaigenbaum et al. (2005) and Bryson et al. (2007) resulted from a global rating of “social interest and pleasure” made in-vivo

during examiner-led assessments designed to elicit social smiling. Rozga et al. (2011) utilized a mother-infant interaction paradigm in which parents were instructed to verbally interact with their infant without touching them while the infant was placed in an infant seat. Extending this research on social smiling in infancy by using a methodologically rigorous experimental design to investigate clinically relevant individual differences would enhance the understanding of positive social affect in infancy.

Together this evidence demonstrates that positive social affect in infants 9 months and older is a social-communicative ability that predicts later social cognitive skills. It further suggests that systematic investigation of social affect in early infancy, prior to the onset of intentional communicative behavior (e.g., anticipatory smiling) could be a compelling measure of social understanding and motivation and a meaningful precursor to social-communicative abilities. In light of the abundance of research using social affect to document the earliest marker of ASD at 6 months, it is critical to increase our understanding of the clinical significance of positive social affect for 6-9-month-old infants.

Social Attention

Typically developing infants are born with an inherent propensity for social attention. This innate proclivity, suggested to be regulated by subcortical attentional mechanisms, helps to direct infant attention in a way that increases cortical input from social stimuli, such as faces (Morton & Johnson, 1991). From birth, infants prefer to look at faces over non-faces (Goren, Sarty, & Wu, 1975; Pascalis & Kelly, 2009). Social attention does not diminish with age (DeNicola, Holt, Lambert, & Cashon, 2013) and follows a specific developmental pattern. By 2 months of age, infants are able to preferentially focus on the eyes and mouth of a face and by 3 months they become sensitive to eye contact and vocal cues (Striano & Reid, 2006). As early as 4 months of

age, infants begin to learn about the world by simply attending to faces, that is they gain information about objects by following adult eye gaze (Gredebäck, Fikke, & Melinder, 2010). This skill is called responding to joint attention and is considered an important precursor to language. Attending differentially to the eyes and the mouth also follows an empirically defined developmental course. Hunnius and Geuze (2004) observed that young infants allocate more attention to the eyes but gradually, as language comprehension and expression develops, develop a preference for gazing to the mouth.

Experimental paradigms in which 6-12-month-old infants are shown complex scenes containing socially relevant stimuli have revealed that infants allocate the majority of visual attention to faces over other non-social stimuli (Aslin, 2009; Frank, Vul, & Saxe, 2011; Frank, Vul, & Johnson, 2009). Again, this visual gaze pattern adheres to a developmental trend. Younger infants in the first year of life tend to focus more on faces in complex scenes, specifically the eyes, whereas older infants exhibit a more sophisticated pattern of looking, spending time attending to other socially relevant aspects of the scene, such as actions of interest and emotional expressions (Frank, Vul, & Sax, 2012). Typically developing infants indisputably prefer to attend to socially relevant stimuli, a robust finding from experiments utilizing both contrived side-by-side visual preference paradigms as well as free-viewing, naturalistic paradigms.

Several research studies have documented disrupted patterns of social attention in infants and toddlers with ASD compared to their typically developing peers. These studies have primarily used two methods for capturing visual attention patterns in infancy: (a) Eye-tracking paradigms that record looking times to social aspects of images or video-recorded scenes and (b) video recorded naturalistic scenarios, such as parent-infant interactions, that are behaviorally coded for infant gaze patterns. These methods have been fruitful in enhancing our understanding of early gaze patterns in infants leading up

to the full expression of ASD at the age of 2 or 3 years. Utilizing eye-tracking, Shic, Bradshaw, and Chawarska (2011) observed that 20-month-old toddlers with ASD prefer to look at background objects in a social scene whereas typically developing toddlers show attentional preference for faces and social activities. Additional evidence also showed that toddlers with ASD have difficulty processing social-specific information (Bradshaw, Shic, & Chawarska, 2010). Similar findings have been documented for infants with ASD as young as 6 months who exhibit less interest in social features of a scene, including faces (Chawarska, Shic, & Macari, 2013). Most recently, Jones and Klin (2013) found that infants with ASD show a progressive decline in looking to the eyes of a face from 2 to 24 months compared to their typically developing peers.

Social attention exhibited by 12-month-old infants with ASD during naturalistic parent-infant interactions is characterized by decreased frequency of looking to the face and overall diminished attention to people (Ozonoff et al. 2010; Osterling, Dawson, Munson, 2002; Wan et al. 2012). Further, 12-month-olds with ASD show diminished attentional responsiveness to socially relevant situations, such as persons in distress (Hutman, Chela, Gillespie-Lynch, & Sigman, 2012) and orienting to their name (Werner & Dawson, 2005). In contrast, 6-month-old infants with ASD appear to demonstrate typical patterns of social attention during parent-infant interactions in prospective research studies, with some preliminary reports of *increased* attention to the caregiver's face for infants with ASD (Ozonoff et al. 2010). This seemingly contradictory finding could be explained by the infant habituation literature, suggesting that infants with ASD are not effectively processing faces at 6 months and so require more time to habituate to faces before disengaging. Retrospective studies incorporating parent interviews and review of home videotapes have reported significant differences in frequency and quality of eye contact in the first 12 months of life (Clifford & Dissanayake, 2008). These authors

suggested that the infants with ASD fail to integrate communicative meaning into eye contact and instead exhibit “empty gaze.” Overall, these findings provide a rationale for research aimed at understanding eye contact in the context of other communicative behaviors, such as facial expression.

Attending to appropriate stimuli in the environment is vital for learning and development. In order to attend to relevant stimuli, it is important to visually scan and prioritize attention, as well as disengage from irrelevant stimuli. Visual disengagement then may then be an important prerequisite skill for attending to and learning about the social environment in infancy. The ability to appropriately disengage develops at approximately 3-4 months of age and has been found to be a specific impairment for older infants with ASD (Zwaigenbaum et al., 2005). Specifically, typically developing toddlers showed slowed visual disengagement from social stimuli, such as faces, while toddlers with ASD did not differentiate social and non-social stimuli and showed comparable visual disengagement from both faces and objects (Chawarska, Volkmar, and Klin, 2010).

In sum, the literature shows that infants with ASD have significant impairments attending to relevant social stimuli in the environment and disengaging from irrelevant stimuli beginning as young as 12 months of age. Research documenting this abnormality at 6 months of age however is just emerging and has yet to observed in the naturalistic context of a parent-infant interaction. Further, research is still needed to understand individual differences in typical patterns of social attention. Evidence demonstrates that social attention is disrupted in older infants with ASD, but the developmental roots of this pattern in relation to autism-specific behaviors (e.g. social engagement and communication) and normal developmental variability (e.g. temperament) has yet to be investigated.

Communication in Infancy

Vocal production begins at birth with infants producing several involuntary vocalizations including crying, vowels, and vegetative sounds (Paul, 2007). Throughout the first 6 months of life vocalizations increasingly represent a display of cognitive state, such as joy and frustration. Canonical babbling is a significant language benchmark that emerges around this time and involves reduplications of vowel-consonant sounds, for example, /*bababa*/ (Oller, Levine, Cobo-Lewis, Eilers, & Pearson, 1998). Research supports a strong relation between babbling and speech such that babbling can be regarded as a determinant for later speech development (Mitchel, 1997). Failure to engage in this activity by 10 months of age is associated with delayed and abnormal language production later in life (Oller, Eilers, Neal, and Schwartz, 1999; Vihman, Ferguson, & Elbert, 1986). Canonical babbling at this stage is not only an important precursor for language development but serves as a cornerstone for social interaction as adults and infants engage in back and forth imitative babbling games. Between 6-12 months of age, infant cognizance of language is evidenced by imitative prosodic contour in expressive vocalizations, sentence-like intonation (i.e., jabbering), the use of exclamations and jargon (e.g., *"uh-oh!"*), and finally acquisition of first words around the first birthday.

Assessment of expressive language development involves documentation of the frequency and quality of infant vocalizations based on naturalistic observation, standardized assessment, and parent report (Paul, 2007). One such standardized assessment, the Mullen Scales of Early Learning (Mullen, 1995), addresses expressive and receptive language in young children birth to preschool. Assessment of expressive language using this measure involves observation of infant vocalization as he or she interacts with the examiner and parent. It also allows for examiner-elicited responses for

behaviors not observed naturally. Parent report measures allow for valid and reliable assessment of infant speech and can contribute to a better understanding of the infant's use of communication outside of the laboratory setting (Thal, O'Hanton, Clemmons, & Fralin, 1999). One such parent report questionnaire, the Communication and Symbolic Behavior Scales – Caregiver Questionnaire (CSBS-CQ), measures the production of sounds and words with strong predictive validity for language skills at two years (Wetherby, Allen, Clear, Kublin, & Goldstein, 2002).

Language comprehension in early infancy additively contributes to language development in the early toddler years. Language learning occurs through repetitive verbal input or, in other words, sustained social interaction. Receptive language development is suggested to precede expressive language and infants begin to understand the symbolic meaning of words as early as 6 months of age (Tincoff & Jusczyk, 1999). Speech perception (i.e., the ability to discriminate similar yet distinct speech sounds unique to an infant's culture) at 6 months of age significantly predicts language ability at two years (Tsao, Liu, & Kuhl, 2004).

Communication development is disrupted in children with a variety of developmental disabilities, including intellectual disability, preterm infants, and infants with ASD. Language delays are often the source of parents' first concerns (Turygin, Matson, Williams, & Belva, 2014). Both expressive and, to a greater degree, receptive language delays appear as early as 12 months of age in infants with ASD (Zwaigenbaum et al., 2005; Macari et al., 2012; Bryson, 2007; Paul, Fuerst, Ramsay, Chawarska, & Klin, 2011; Werner & Dawson, 2005). These findings have been replicated in direct observational assessment using the Mullen Scales of Early Learning and parent report of infant language using the CSBS-CQ (Veness, et al. 2012). Despite significant difficulties in early language acquisition for infants with ASD, almost no differences in language abilities

of infants with and without ASD at 6 months have been observed. Maestro et al. (2002) serves as the single exception in which 6-month-olds with ASD were observed to vocalize toward people less. However, the dependent variable in this study confounds attention toward people with vocalizations, making it difficult to discern the finding as a deficit in social attention or vocal production. The extent to which early social-communication and vocal production are related to positive social affect has yet to be investigated.

Temperament

The process of identifying abnormalities in early development that may predict later psychopathology is complicated by normal variability that is expected in typical development. Temperament is considered one of the factors contributing to variability in normative development. While temperament may be related to expression of certain behaviors within the bounds of a normal developmental trajectory, it is thought to be a separate construct distinct from expression of developmental disorders, such as ASD. An understanding of how temperament may explain some of the variability in the expression of suspected early markers of ASD would help to distinguish whether aberrant behavior remains within the bounds of normal development or if it is indicative of developing psychopathology.

Temperament can be generally defined as a construct of stable, biologically determined differences in infant and child behavior that make up a 'behavior style' (Rothbart, 1981). Endeavors to define and quantify temperament have been, in part, motivated by the study of 'child effects', that is effects on development that can be attributed to the individual child. It has also been considered as a key factor in determining childhood resilience (Thomas & Chess, 1984). Rothbart and Derryberry (1981) originally described temperament as a product of two separate constructs: reactivity and self-regulation. Reactivity refers to the excitability, responsivity, or arousability of an

individual. Self-regulation refers to behavioral processes used to modulate reactivity, such as behavioral approach, withdrawal, inhibition, and executive attention (Rothbart, Ahadi, & Evans, 2000). Temperament is most commonly assessed with a parent questionnaire that generates several clusters and scales yielding a set of higher order constructs: Surgency, Negative Affect, and Effortful Control (Gartstein & Rothbart, 2003). Each of these broader constructs is assessed through aggregation of the frequency and intensity of several infant behaviors, as rated by a caregiver. Surgency is defined by positive emotionality and approach, and includes items assessing smiling and laughter, lack of shyness, impulsivity, and high intensity pleasure. The Surgency subdomain evaluates an infant's positive emotional reaction to a variety of changes in the environment, such as being put in a carseat or social stimulation. Thus, "positive emotionality" is defined by positive reactions to both social and nonsocial situations. The Negative Affect dimension includes items that address shyness, discomfort, fear, anger, frustration, and sadness. The Effortful Control factor is a product of behaviors related to infant inhibitory control, attentional focus, low intensity pleasure, and perceptual sensitivity.

Temperament has been studied in an effort to characterize individual differences in developmental outcomes of typically developing infants, toddlers, and children. Research has resulted in identification of specific early temperamental profiles that help to explain variability in the development of social-communicative skills, including language acquisition and social competence. In regard to language development, the role of positive emotionality in facilitating or hindering language development has been debated. Bloom (1998) suggested that increased positive or negative emotionality in infancy would cause infants to use their attentional and cognitive resources to regulate their emotional reactivity rather than learning language. However, several research studies have found smiling and laughter to be positively correlated with advanced

language comprehension. For example, expressive language level in 20-month-old toddlers can be predicted by a temperament consisting of greater adaptability, more positive mood, and greater persistence at 13 months (Dixon & Smith, 2000). This same study also showed that longer duration of orienting (behavior related to Effortful Control) as well as increased smiles, laughter, and soothability (behaviors related to Surgency) in 7-month-old infants were related to language comprehension at both 7 and 10 months. Although these findings were contrary to Bloom (1998)'s hypothesis, Dixon and Smith take a transactional theoretical standpoint and claim that positive emotionality could lead to more frequent social interactions, effectively having a positive downstream effect on language-learning.

Similarly, positive emotional reactivity in 9-month-old infants was observed to correlate with their ability to initiate joint attention with an examiner during a standardized behavioral assessment (Vaughan, et al., 2003). Authors suspect that infants who exhibit positive responses to novelty and approach behaviors will be more likely to initiate joint attention in response to a new experience with an unfamiliar examiner. In one of the only studies to investigate social-communicative associations of very early temperament style, Morales et al. (2000) found that activity level, duration of orienting, and smiling and laughter at 6 months were all positively associated with receptive language at 12 months. No significant correlations were observed with early temperament and later expressive language at 12 months.

Associations between temperament and social skills continue to be empirically documented throughout early childhood. Teacher-reported social competency has been significantly related to temperamental styles of high effortful control (Blair, Denham, Kochanoff, Whipple, 2004) and self-regulation (Diener and Kim, 2004), decreased anger and frustration (Diener and Kim, 2004), and generally more "easy" temperaments (Farver

and Branstetter, 1994). Perhaps analogously, more “difficult” temperaments early in life, at 12 and 18 months, have been associated with later developing externalizing problem behaviors at 3 and 5 years (Keenan, Shaw, Delliquadri, Giovanelli, & Walsh, 1998).

Although specific constellations of temperamental styles can be associated with developmental psychopathology, temperament and psychopathology remain conceptualized as separate constructs (Lemery, Essex, & Smider, 2002). Temperament can be thought of as a way to describe the normal range of variation in child behavior, whereas psychopathology describes extremes in child behavior that impairs functioning and often require intervention. Thus while children with temperamental styles characterized by high negative affectivity may be described as “difficult,” their behavior may not extreme enough to warrant diagnosis of a behavioral or developmental disorder. However, children with conduct disorder or autism spectrum disorder are more likely to score high in negative affectivity than their typically developing peers.

Temperament may also serve to explain the particular presentation of a psychological disorder rather than the source of the psychopathology. For example, a child with ASD who exhibits positive emotionality in response to physical activities and highly stimulating social interactions may exhibit a temperamental style consisting of high levels of Surgency, whereas another child with ASD and similar cognitive and verbal abilities who prefers isolation and low-intensity activities, may exhibit a temperamental style constituting very low levels of Surgency. Thus, underlying temperamental structure may serve as a possible candidate for variability in psychopathological symptom expression (Muris & Ollendick, 2005). The relation between psychopathology and temperament becomes important in regard to early identification of psychological disorders. It is important to distinguish certain behaviors as part of “personality” v. an emerging psychological disorder. Falsely identifying a temperamental characteristic as a

psychological disorder carries with it the risk of increasing parent stress and inefficient use of the already limited early intervention resources. On the other hand, attributing concerning symptoms of psychopathology to temperament, could delay onset of early intervention and be detrimental to long-term prognosis for that child (Keenan & Wakschlag, 2000). Aspects of psychopathology and temperament in early childhood have been successfully differentiated in parent reports. Sheeber (1995), for example, found that following an intervention program for children with behavior disorders, parent reports revealed improvement in behaviors related to their child's symptoms, but measures of temperament showed no changes after intervention. This study, among others, brings promise that behaviors related to temperament and psychopathology can be successfully measured and differentiated using parent report.

Dimensions of temperament have been investigated in children with ASD in an attempt to account for the heterogeneity and spectrum nature of ASD. Konstantareas & Stewart (2006) found that parents rated their child with ASD to be lower in Effortful Control. Additionally, children with ASD who were less socially responsive and engaged were judged by their parents to be more temperamentally "difficult" as defined by combining scales of rhythmicity, approach/withdrawal, adaptability, intensity, and mood (Kasari & Sigman, 1997). Using factor analysis Garon et al. (2009) found that children with ASD were distinguished from typically developing controls by a discriminant function they termed "Behavioral Approach," with more affected children exhibiting lower scores on this function. Behavioral Approach consisted of low attention shifting, low positive anticipation, and high activity level for children with ASD at three years.

The Infant Behavior Questionnaire (IBQ, Gartstein & Rothbart, 2003) has been used in prospective studies of infants with ASD in attempts to encapsulate a comprehensive clinical profile of autism in infancy, when the disorder is just emerging. Research studies

using this measure found that 6-7-month-old infants with ASD exhibited lower activity levels, which then rapidly transformed into increased distress reactions, longer duration of orienting to objects (Zwaigenbaum et al., 2005; Bryson et al., 2007), and decreased smiling, laughter, and effortful control (Clifford, Hudry, Elsabbagh, Charman, & Johnson, 2013) by 12-14 months of age. Finally, at 2-years-old, parents of toddlers with ASD report significantly greater Negative Affect (i.e., sadness and shyness) than typically developing toddlers (Clifford et al., 2013). Given the heterogeneity observed in toddlers with ASD, more research is needed to understand how varying temperamental profiles affect presentation of the core symptoms of ASD. For example, it is possible that lower levels of Surgency observed in toddlers with ASD are related to increased anxiety rather than decreased social competence. Furthermore, as Clifford and colleagues (2013) suggest, it is possible that certain aspects of the larger subdomains derived from the IBQ, such as Surgency, could be conflating different substructures that are both elevated (e.g., behavioral approach toward objects) and diminished (e.g., enjoyment of social interaction) in infants and children with ASD.

Overall, specific temperamental profiles have been associated with developmental outcomes including language, joint attention, and autism symptomology. In regard to typical development, a temperament style consisting of high positive emotionality as well as increased attentional control in infants and toddlers facilitates expressive and receptive language development and joint attention. It is then not surprising that infants and children with ASD exhibit decreased positive emotionality and effortful control and increased negative affect. In the first year of life, limited evidence supports that temperament consisting of increased positive emotionality and duration of orienting at 6 months is related to advanced receptive language abilities. This is further supported by 6-month-old infants with ASD exhibiting lower activity levels. Additional research is needed

to better understand how temperamental styles may be related to concurrent social-communicative abilities in early infancy.

The Current Study

Social Affect as an Indicator of Developmental Psychopathology in Infancy

The presented literature demonstrates that early social-communicative behavior has been emphasized as an important predictor of later developmental psychopathology, especially autism spectrum disorder. Social smiling (referred to as positive social affect throughout this manuscript) is among the earliest developing social behaviors. Yet the significance of individual variability in the expression of positive social affect for 6-8-month-old infants in relation to concurrent measures of social-communicative abilities has not been directly examined. The question in the literature remains – Is expression of positive social affect during dyadic parent-infant interactions in 6-8-month-old infants a meaningful indicator of social functioning in infancy? For example, is positive social affect related to social communicative abilities at this age? Or rather, is it an expression of typical individual variation in development, such as temperamental style? Research is needed to gain a better understanding of the significance of positive social affect in infancy.

Research Questions

The purpose of this study is therefore to address the implication of individual differences in positive social affect for 6-8-month-old infants. Studies investigating social behavior in early infancy as a means of identifying early markers for ASD have demonstrated mixed findings. Some groups have established the absence, or marked attenuation, of positive social affect as an early predictor for ASD, while others have identified no such relation. A better understanding of how social affect in early infancy is related to communication, autism symptomology, and temperament could have significant implications for the use of positive social affect as an early behavioral marker for ASD. Understanding the interrelations of early developing behaviors is necessary to best isolate

abnormalities and develop profiles of typical and atypical development. Documenting individual differences in social affect as early as 6 months will contribute to a broad theoretical understanding of social development as well as to early detection methods of ASD in infancy. This study aims to extend research related to early development of social affect and document individual differences of positive social affect exhibited during social interactions by addressing the following research questions for 6-8-month-old infants:

1. Is positive social affect during structured parent-infant interactions correlated with infant social-communication?
2. Is positive social affect during structured parent-infant interactions correlated with infant vocal production?
3. Is positive social affect during structured parent-infant interactions correlated with autism symptomology?
4. Is positive social affect during structured parent-infant interactions correlated with infant temperament?

In addition to these primary research questions, the following secondary research questions are explored:

1. Do demographic variables effect significant clinical correlates of positive social affect?
2. Is social attention, regardless of affect, correlated with social-communication, vocal production, autism symptomology, or infant temperament?
3. What are the interrelations between the clinical measures of social-communication, vocal production, autism symptomology, and infant temperament?

Previous research has identified associations between social affect in 12-month-old infants and later social-communicative abilities and autism symptomology. Additionally, sharing positive affect in social contexts has been consistently associated with intentional

communication, such as initiation of joint attention, in older infants. This research supports the hypothesis that positive social affect in 6-8-month-old infants will be correlated with social-communicative behavior. In contrast, there is minimal research support for the relation between positive social affect and vocal production at this age. For this reason, and given the lack of communicative function of vocalizations for 6-8-month-old infants, it is predicted that there will be no relation between positive social affect and vocal production. In regard to autism symptomology, social smiling in infants younger than 9 months has thus far not distinguished between infants with and without ASD. Therefore, it is unlikely that ratings of autism symptoms will be correlated with positive social affect. Finally, if positive social affect during structured parent-infant interactions serves as a unique indicator of social-communication, it is unlikely that it will be related to specific temperamental styles, as temperament is a construct distinct from developmental psychopathology. The following hypotheses are therefore proposed:

1. Positive social affect will be positively correlated with the social-communicative abilities.
2. Positive social affect will not be correlated with measures of vocal production.
3. Positive social affect will not be correlated with autism symptomology.
4. Positive social affect will not be correlated with the Surgency, Negative Affect, or Effortful Control dimensions of temperament.

Method

Participants

Inclusion criteria for participation was as follows: (a) infant was between 6 months, 0 days and 8 months, 30 days, (b) infant must have been born at least 37 weeks gestation, (c) infant was a single birth, e.g. was not a twin, (d) parent reported no known genetic or neurological abnormalities, (e) parent reported normal hearing and visual acuity, (f) infant had no immediate family members with an Autism Spectrum Disorder, and (g) the infant's female caregiver was available for participation. Differences in infant-mother and infant-father dyadic interactions have been documented and so only infant-mother dyads were included in this study. Participants were recruited through advertisements around the community as well as local family and infant social and support groups. No compensation was provided for this study, though parents were provided with general feedback regarding their infant's development following the assessment.

A total of 33 infant-mother dyads were included in the final analysis. The mean age for all infant participants was 6.85 months (*SD* = 0.87). Infant participants consisted of 20 males and 13 females. All mothers were primarily English-speaking. Data was additionally collected on parental concerns regarding their infant's development and significant maternal or paternal psychological history. 76% of parents reported to have no concerns about their child. Of those who did report concerns, three parents listed social concerns (e.g., lack of imitating, separation anxiety, and not picking up on the emotions of other infants), three parents listed motor concerns (e.g., not yet crawling, not yet rolling over, and mild dystonia), two parents listed language concerns (e.g. not making enough sounds or imitating sounds), and one parent listed low weight as a concern. The majority of parents reported no significant parental psychological history (79%), however

four parents reported a history of maternal depression, three reported a history of paternal depression, and one reported a history of maternal anxiety. Full demographic information is included in Table 1.

Table 1

Participant Demographic Information

Characteristic	Number of Participants (Percent of Sample) N=33
Age	
6 Months	15 (46%)
7 Months	8 (24%)
8 Months	10 (30%)
Sex	
Male	20 (61%)
Female	13 (39%)
Ethnicity	
White	29 (88%)
Asian	2 (6%)
Mixed	2 (6%)
Parent-Reported Concerns	
No Concerns	25 (76%)
Social Concerns	3 (9%)
Motor Concerns	3 (9%)
Language Concerns	2 (6%)
Weight Concerns	1 (3%)
Parent Psychological History	
None Reported	26 (79%)
Maternal Depression	4 (12%)
Maternal Anxiety	1 (3%)
Paternal Depression	3 (9%)
Paternal Anxiety	0

Setting and Procedure

Parents were instructed to participate in the study at a time in which their infant would be functioning optimally, including scheduling an appointment to the clinic before or after naps and feeding times. All procedures occurred in clinic testing rooms located at the University Autism Center. Rooms were equipped with adult-sized tables and chairs and each contained a digital camera for filming experimental procedures. The clinical assessments and parent-infant interactions took place in separate rooms. Clinical assessments occurred first in a room with an adult-sized table and chairs with a tripod-mounted video camera to capture the examiner, infant, and mother. During the clinical assessment, infants were placed on the parent's lap at a table directly across from the examiner. Prior to beginning the assessments, the examiner explained the procedures to the parent and completed informed consent while the infant was given a toy and allowed time to acclimate to the new environment and the examiner.

The structured dyadic parent-infant interactions occurred in a room with minimal distractions and no toys were available to the infant or parent. The parent sat in an adult-sized chair at a table while holding the infant on a flat surface directly in front of her, approximately 16 inches away (see Figure 1). This setup is accommodating to infants at a variety of motor development stages, enabling them to easily look to the parent's face even with limited head and neck control. Additionally, infants in this context, compared to placement in an infant seat, have increased control over their visual attention. Parents were instructed to play with their infant as they normally would at home in order to engage the infant in a social interaction, encouraging looking and smiling. Activity suggestions were provided to each parent as follows: talking, singing, and peek-a-boo. The camera was situated behind and to the right of the mother so as to capture the infant's eyes and facial expression in addition to a partial view of the mother's facial expression

and eyes. One participant was excluded due to excessive fussiness during this procedure, resulting in early termination of the experiment. Parent report measures were completed following the parent-infant dyadic interaction.

Figure 1: Example of experimental setup during the structured parent-infant interaction.

Measures

Demographic Questionnaire. An in-house intake questionnaire was completed in order to collect relevant demographic and contact information for the participants. This form included questions regarding date of birth, race/ethnicity, length of pregnancy, developmental concerns, significant parent psychological history, and siblings.

Parent-infant interaction measures. All primary research questions involved the quantification of infant positive social affect expressed during a structured dyadic parent-infant interaction. Additionally, one of the secondary research questions evaluated the relations between clinical measures and social attention during structured dyadic parent-infant interactions. Therefore, both Positive Social Affect and Social Attention were derived from behavioral coding of the parent-infant interactions.

Each parent-infant dyadic interaction was filmed for later behavioral coding. The interaction was structured such that parents were given specific instructions and were not allowed to incorporate toys into their play. Each interaction lasted for five minutes and was coded in ten-second intervals. The lead investigator of this study and a trained undergraduate research assistant completed all behavioral coding. The undergraduate research assistant was in Psychology, had foundational knowledge of infant and child development, and was blind to the hypotheses of the study. The coder was trained to 80% reliability on the coding system and inter-rater reliability was subsequently calculated for 10% of the videos, selected at random. A percent agreement of 80% and Kappa above .7 is considered satisfactory agreement (Kazdin, 2011). Percentage agreement and the corresponding Kappa values for each measure are reported below.

Positive affect. Infant affect was coded using a 6-point Likert scale (see *Affect Coding Definitions* in Table 2). Affect coding definitions were operationalized using modified descriptions of previously developed affect rating scales (Koegel, Vernon,

Koegel, 2009; Koegel, Singh, Koegel, Hollingsworth, & Bradshaw, 2014). Each ten-second interval of the parent-infant interaction was given a single affect rating that best captured the infant's overall affect during that interval. According to these definitions, a rating of 5 or 6 is considered positive affect, 3 or 4 is neutral affect, and 1 or 2 is negative affect. Examples of behavior that would yield a positive affect rating include laughter, smiling, and other indications that the infant is enjoying the interaction. For the purposes of this study, negative and neutral infant affect states were not included in the analysis. Inter-rater agreement for ratings of positive affect was calculated with percentage agreement and overall Kappa. Percent agreement was medium to high, ranging from .57-.90 with a mean of .81, and the Kappa statistic revealed a substantial agreement (Kappa = .634, $p < .001$).

Table 2

Infant Affect Coding Definitions

Affect	Likert Rating	Definition
Positive	6	Laughter; clear open or close mouth smile
	5	Subtle smile; other indications of enjoyment, such as motor activity or sounds.
Neutral	4	Neutral facial expression; instances of subtle smiles that last less than three seconds; passive acceptance of the interaction
	3	Neutral facial expression; staring; bored or looking for another activity
Negative	2	Low intensity whining; discomfort; can be re-directed
	1	Crying, screaming, mother may need to pick up or hold close

Note: Any, not all, of the listed behaviors in a category can be present to meet criteria for a particular rating.

Social Attention. Infant gaze direction was partial-interval coded. Raters recorded the occurrence of Social Attention for each interval in which an infant's eyes were judged to be looking at the face of the mother during the parent-infant interaction. Percent agreement for the two raters ranged from .80 to .93 with an average of .87. Additionally, the Kappa statistic resulted in substantial agreement (Kappa = .73, $p < .001$). The Social Attention measure is expressed in proportion of intervals in which each infant exhibited social attention.

Positive Social Affect. The primary measure for this study, Positive Social Affect, was calculated by combining the Positive Affect and Social Attention measures. Each interval that an infant was rated as exhibiting both positive affect (i.e., smiling or laughing) and social attention (i.e., looking at the mother's face) was then considered an interval in which the infant expressed Positive Social Affect. The Positive Social Affect measure for this study is expressed as the proportion of intervals in which each infant exhibited positive social affect.

Social-Communication measures. The first primary research question concerns assessment of infant social-communication. Social-communication was measured using two complementary assessments: the Mullen Scales of Early Learning Receptive Language domain and the Communication and Symbolic Behavior Scales – Caregiver Questionnaire (CSBS-CQ) Social composite. The Mullen Receptive Language is a clinician-administered assessment focused primarily on responsivity to social-communication. The CSBS-CQ Social composite is a parent-report assessment focused on a broader range of social-communicative behavior.

Mullen Language Scales of Early Learning. The Mullen Scales of Early Learning is a standardized developmental assessment for children birth to 68 months of age. It consists of five subscales covering cognitive, language, and motor development that each

yield a single *t* score. *T* scores have mean of 50 and a standard deviation of 10. In clinical practice, *t* scores less than 30 (two standard deviations below the mean) typically indicate the need for early intervention while a *t* score between 31-35 (1.5 standard deviations below the mean) indicate an infant who is "at-risk" for developmental delays (Shank, 2011). It has good internal consistency (.75-.83), test-retest reliability (.82-.85), inter-rater reliability, and convergent validity with other similar developmental assessments (e.g., Bayley Scales of Infant Development: .7) (Mullen, 1995). Participants in this study were administered the Mullen Scales of Early Learning by an examiner who was trained to reliability on the administration and scoring of the Mullen by a doctoral level developmental psychologist with expertise in infant and toddler development.

The Receptive Language domain of the Mullen Scales of Early Learning was the only domain included in the current study. The Receptive Language domain is intended to assess a child's ability to decode verbal input while minimizing output requirements. In general, infants in the first year of life are observed to develop receptive language skills more rapidly than expressive language abilities. Infants between 6-8 months of age are expected to attend and respond to voices, sounds, and faces. Additionally, they are beginning to attach meaning to prelinguistic visual and physical cues. For example, infants in this stage of development will respond to a voice or face by vocalizing, respond to the spoken word "up" accompanied with a gesture, and respond to voices and their name by turning their head. Individual *t* scores for this subscale were included in the analysis as one aspect of social-communication.

Communication and Symbolic Behavior Scale – Caregiver Questionnaire (CSBS-CQ). The CSBS-CQ is a parent questionnaire that provides scores for seven clusters, which are then combined to create three composites. The seven cluster and three composite scores are expressed in standard scores that are based on a mean of 10 and standard

deviation of 3. The Social composite is comprised of three clusters: Emotion and Use of Eye Gaze, Communication, and Gestures. The Emotion and Eye Gaze cluster consists of items related to how infants use gaze shifts and facial expressions to communicate with an adult, including sharing positive affect. The Communication cluster addresses rate and types of prelinguistic communication, such as joint attention. The Gestures cluster includes an inventory of conventional gestures, such as clapping and waving. The Social composite standard score is included in this analysis as the second component of social-communication. The CSBS has good validity and test-retest reliability (Social composite: .70; Speech composite: .73) tested on a large sample of 790 children (Wetherby & Prizant, 2002).

Vocal production measure. The second primary research question concerns vocal production. Vocal production is measured using the Speech composite of the CSBS-CQ. The Speech composite is comprised of two clusters: Sounds and Words. This includes an inventory of consonant sounds the infant is currently using as well as frequency of vocalizing and babbling. The Speech composite standard score is included in this analysis as a measure of vocal production.

Autism symptomology measure. The third primary research question requires measurement of autism symptomology in 6-8-month-old infants. The Autism Observation Scale for Infants (AOSI) was administered to assess autism symptoms in infancy.

Autism Observation Scale for Infants (AOSI). Diagnosis and symptomology of autism in children, adolescents, and adults, has most commonly been characterized with the Autism Diagnostic Observation Schedule (ADOS, Lord et al., 2000). This instrument, however, is not appropriate for infants younger than 12 months of age. The Autism Observation Scale for Infants (AOSI, Bryson et al., 2008) was developed to provide an index of behaviors consistent with the later development of ASD for younger infants. The

AOSI is considered an observational clinical research measure for infants 6-18 months. Inter-rater (.68-.94) and test-retest (.61-.68) reliability of this measure is considered good to excellent (Bryson, et al. 2008). The measure consists of 15 items that assess behaviors related to social, attention, and motor abnormalities. Each item, or target behavior, is each given a score of 0, 1, 2, or sometimes 3. Specific scoring codes are provided for each item, but generally a score of 0 represents typical behavior, 1 represents inconsistent, partial or questionable behavior, 2 represents marked impairment or atypical behavior, and 3 represents a complete lack of the behavior, or extremely atypical behavior. Some target behaviors are assessed through observation of spontaneous behaviors during naturalistic interaction with the examiner throughout the assessment (e.g., Eye Contact, Social Interest, and Motor Control) while others require systematic *presses* to elicit particular target behaviors (e.g., Response to Name, Disengagement of Attention, and Imitation). Table 3 depicts all AOSI items and their definitions. The Total Symptom Severity score included in this analysis is the sum of all 15 item scores, and represents the severity of behavioral autism markers. Elevated scores on the AOSI for 12-month-old-infants has been associated with the development of ASD at 24-month outcome (Bryson, et al., 2008). Individual items predicting ASD at outcome include atypical eye contact, lack of orienting to name, decreased social smiling and social interest, and increased sensory-oriented behaviors (Zwaigenbaum et al., 2005).

Administration of the AOSI takes approximately 15-20 minutes and was administered first in each experimental visit after an initial warm-up period with the infant, examiner, and mother. The AOSI was administered by an examiner who was research trained to administration and scoring reliability by the developers of the instrument.

Table 3

Autism Observation Scale for Infants Item Descriptions

AOSI Item	Target Behavior Assessed
Visual tracking	Ability to visually follow a moving object laterally across the midline.
Disengagement of attention	Ability to disengage and move eyes/attention from one of two competing visual stimuli.
Orientation to name	Ability to move head and/or eyes toward and look at the examiner when name is called.
Anticipatory social response	Ability to anticipate and enjoy social (vs. physical) cause-effect relationships.
Imitation	Ability to reproduce an action produced by the examiner.
Social babbling	Ability to engage in back-and-forth (reciprocal) vocalizations with the examiner.
Eye contact	Ability to consistently establish appropriately sustained eye contact with the examiner.
Reciprocal social smile	Ability to smile in response to the examiner's smile.
Coordination of eye gaze and action	Ability to co-ordinate gaze with actions on objects.
Behavioural reactivity	General responsiveness, including under reactivity and over reactivity, to the activities and toys introduced, and to the examiner's actions.
Social interest and shared affect	Ease of engagement and interest in activities, and ability to share positive affect with the examiner.
Transitions	Ease and consistency with which toys are relinquished and movement is made from one activity to another.
Motor control	Degree to which motor behaviour is goal-directed, organised and modulated.
Atypical motor behaviour	Presence of developmentally atypical gait, locomotion, motor mannerisms/postures or repetitive motor behaviours.
Atypical sensory behaviour	Presence of developmentally atypical sensory behaviours in any modality (e.g. smelling of toys, staring at hands/shapes/objects, or feeling textures).

Note. Item descriptions adapted from "The Autism Observation Scale for Infants: scale development and reliability data" by S. Bryson, L. Zwaigenbaum, C. McDermott, V. Rombough, and J. Brian, 2008, *Journal of autism and developmental disorders, 38*(4), p. 733.

Temperament measure. The fourth and final research question involves measurement of temperament. This was evaluated with the Infant Behavior Questionnaire – Revised Very Short Form, a parent-report measure of infant temperament.

Infant Behavior Questionnaire – Revised Very Short Form (IBQ-R). The IBQ-R, Very Short form is a parent report instrument consisting of 36 items (IBQ-R, Gartstein & Rothbart, 2003). Each item on the IBQ-R requires the parent to rate how often their infant engages in a particular behavior on a 7-point Likert scale, with higher scores indicating higher frequency. The measure results in scores for three dimensions of temperament: Surgency, Negative Affect, and Effortful Control. Each dimension score is calculated by averaging the responses (1 through 7) for the items that make up the dimension. The standard version of the IBQ-R has good internal consistency for each of the three dimensions (.91-.92) and moderate inter-rater agreement between primary and secondary caregivers (between .31 and .7)

Surgency. Surgency can also be thought of as extraversion and is defined by items assessing impulsivity, high intensity pleasure, and activity level. Higher scores on the Surgency dimension could result from high ratings on items such as frequent laughing and vocalizing and increased motor activity. A total of 13 items make up the Surgency domain.

Negative Affect. The Negative Affect domain assesses behaviors related to sadness, discomfort, fear, and anger/frustration. This domain includes items such as frequent crying and a tendency to be easily upset. A total of 12 items make up the Negative Affect domain.

Effortful Control. The Effortful Control subscale is defined by items assessing low intensity pleasure, inhibitory control, attentional focusing, and perceptual sensitivity. This domain includes items such as propensity to be easily soothed and a preference for low-intensity activities. A total of 12 items make up the Effortful Control domain.

Data Analysis Plan

Power analysis. A power analysis was conducted to determine the sample size required to address the primary research questions of this study. In order to detect a correlation with a medium effect size (r = .3) with a power of 80% at the .05 level, a sample size of 85 is required for a two-tailed test. In order to detect a large effect (r = .5) with a power of 80% at the .05 level, a sample size of 28 is required for a two-tailed test (Cohen, 1992). The current study includes a total of 33 participants. This sample size is sufficient to detect moderate to large effects, but will likely fail to detect small to moderate effects. Therefore, any significant results from Pearson bivariate analyses in which the correlation coefficient is small to medium should be interpreted with caution and warrants replication.

Preliminary data screening. Data analyses were conducted in several stages. First, preliminary data screening was performed by evaluating descriptive statistics of the dependent measures. This included an identification of extreme values or outliers, and assessment of normality of the distributions.

Primary data analysis. All dependent measures were quantitative and interval or ratio levels of measurement and so Pearson bivariate correlations were used to address the primary research questions. First, the Positive Social Affect measure was correlated with Mullen Receptive Language *t* scores and CSBS-CQ Social composite standard scores to assess the relation between positive social affect and social-communication. Second, Positive Social Affect was correlated with CSBS-CQ Speech composite standard scores to assess the relation between positive social affect and vocal production. Third, Positive Social Affect was correlated with AOSI total scores to assess the relation between positive social affect and autism symptomology. Finally, Positive Social Affect was correlated with

the Surgency, Negative Affect, and Effortful Control domains of the IBQ-R to assess the relation between positive social affect and temperament.

A total of seven correlational analyses are being run to address the four primary research questions. In order to decrease the risk of obtaining a Type I error with a set alpha level of .05, a Bonferroni adjustment was applied such that each individual correlation must have a *p* value less than .007 in order to be considered statistically significant.

Secondary data analysis. Additional analyses were run to further explore the findings of the primary analyses. First correlations between demographic variables and variables involved in any significant relations identified in the primary analyses were conducted. If significant correlations were found, these demographic variables were then included as covariates and a Partial correlation analysis was conducted. Second, Pearson bivariate correlations were conducted with the Social Attention variable derived from the parent-infant interactions and all dependent measures. This was to evaluate the differential effect of infant attention to the caregiver's face during the parent-infant interaction regardless of coordinated affect. As an additional exploratory analysis, correlations between all clinical dependent measures were conducted. This was done to explore interrelations between the following clinical measures: Mullen Receptive Language, CSBS-CQ Social composite, CSBS-CQ Speech composite, AOSI total score, and the IBQ-R Surgency, Negative Affect, and Effortful Control domains.

Results

Descriptive Statistics

The final sample consisted of 33 participants. Descriptive statistics including range, mean, and standard deviation for each measure are reported below. The distribution of each variable is also described. Generally, it is acceptable for kurtosis to fall between −2 and +2. Table 4 displays the range, mean, standard deviation, and values for skewness and kurtosis for all measures. All values met assumptions of normality and no transformations for any variable were required. Outliers were defined as any value that exceeded 3 standard deviations above or below the mean. No extreme outliers were identified and so all participants were included.

Table 4

Descriptive Statistics

Measure	Range		Mean (SD)	Skewness	Kurtosis
	Minimum	Maximum			
Positive Social Affect (Proportion)	.00	.60	.29 (.18)	-0.19	-1.14
Social Attention (Proportion)	.25	.90	.61 (.18)	-0.18	-0.9
Mullen Receptive Language *t* score	33	63	46.85 (7.52)	0.21	-0.14
CSBS Social Composite Standard Score	7	17	11.97 (2.6)	-0.2	-0.18
CSBS Speech Composite Standard Score	3	17	9.3 (2.87)	0.79	1.9
AOSI Total	2	16	7.24 (3.98)	0.57	-0.85
IBQ-R Surgency Total	2.55	5.91	4.75 (0.85)	-0.76	-0.11
IBQ-R Negative Affect Total	2	5.33	4.09 (0.73)	-0.12	-1.32
IBQ-R Effortful Control Total	3	6.30	4.92 (0.71)	-0.15	-0.36

Behavioral measures. The proportion of intervals in which infants exhibited positive affect, regardless of where they were looking, ranged from .00 to .60 with an overall mean of .28 (*SD* = .18) across participants. The proportion of intervals in which the infants looked to the face of their caregiver during the dyadic interaction ranged from .25 to .90 with an overall mean of .61 (*SD* = .18) across participants. The proportion of time in which the infants exhibited positive social affect during the five-minute parent-child interaction ranged from .00 to .60 with an overall mean of .32 (*SD* = .18) across participants. This proportion is equivalent to approximately ten 10-second intervals in which the infants exhibited positive social affect.

Primary Analyses

Social-communication. The first research question addressed the hypothesis that Positive Social Affect would be related to infant social-communication. Social-communication was measured with two complementary assessments. The first resulted from the Receptive Language domain of the clinician-administered assessment Mullen Scales of Early Learning. The second was the Social composite of the parent-report measure CSBS-CQ. The Mullen Receptive Language *t* scores for the current sample ranged from 33 to 63 with an overall mean of 46.85 (*SD* = 7.52) across participants. The Social composite standard score resulted in a mean of 11.97 (*SD* = 2.60), ranging from 7 to 17 across participants.

A Pearson bivariate correlation was conducted with the two measures of social-communication and Positive Social Affect to test the hypothesis that there would be a significant, positive relationship between social-communication and Positive Social Affect. This hypothesis was partially confirmed with a significant relation between Positive Social Affect and Mullen Receptive Language (r = .428, p = .007) but no relationship was observed between Positive Social Affect and the CSBS-CQ Social composite (r = .146, *ns*).

The scatter plot of Positive Social Affect and Mullen Receptive Language is displayed in Figure 2. Table 5 displays all seven Pearson correlations run for four primary research questions.

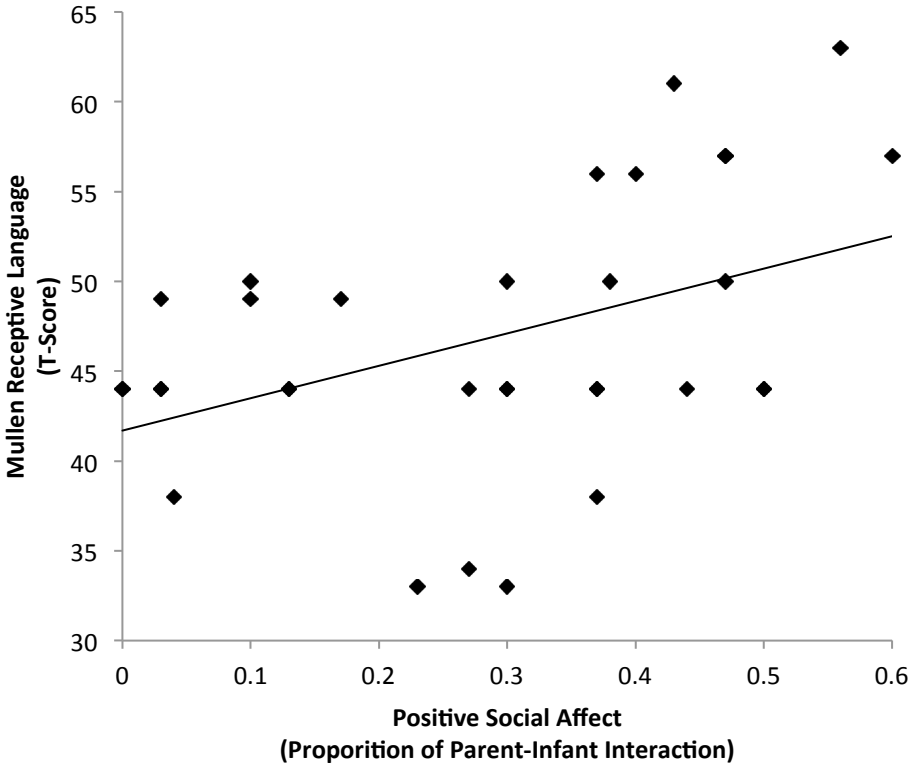

Figure 2: Scatter plot of proportion of intervals with positive social affect (x-axis) and Mullen Receptive Language (y-axis); $R^2 = 0.18$

Table 5

Correlations Between Positive Social Affect and Social-Communication, Vocal Production, Autism Symptoms, and Temperament

Clinical Measure	Positive Social Affect	
	Correlation Coefficient (*r*)	*p*-value
Social-Communication (N=33)		
Mullen Receptive Language	.428	.007
CSBS-CQ Social composite	.146	.418
Vocal Production (N=33)		
CSBS-CQ Speech composite	-.118	.512
Autism Symptomology (N=33)		
AOSI Total	-.166	.357
Temperament (N=30)		
Surgency	.042	.824
Negative Affect	.098	.607
Effortful Control	-.125	.511

Vocal production. The second primary hypothesis of this study was that vocal production would not be significantly associated with infant positive social affect. Vocal production was measured with the CSBS-CQ Speech composite standard score. The Speech composite resulted in an overall mean of 9.3 (*SD* = 2.87) with scores representing the entire range from 3 to 17 across participants. This hypothesis was supported and a Pearson bivariate correlation resulted in a non-significant result (*r* = -.118, *ns*).

Autism symptomology. A third analysis used a Pearson bivariate correlation to evaluate the relation between positive social affect and autism symptomology using the AOSI total score. The average total score on the AOSI was 7.24 (*SD* = 3.97) with scores ranging from 2 to 16 across participants. The result of this analysis confirmed the hypothesis that these measures would not be significantly related (*r* = -.166, *ns*).

Temperament. The final primary analysis tested the relation between positive social affect and infant temperament. The IBQ-R temperament measure provides scores for three subscales: Surgency, Negative Affect, and Effortful Control. This measure has an N of 30 due to three participants who were unable complete the questionnaire during their visit to the clinic and attempts to obtain a completed survey within one week of the experiment were unsuccessful. The Surgency subscale ranged from 2.55 to 5.91 and resulted in an overall mean of 4.75 (*SD* = .85) across participants. Scores on the Negative Affect subscale ranged from 2.82 to 5.33 with a mean of 4.09 (*SD* = .73) across participants. The Effortful Control subscale ranged from 3.33 to 6.30 and resulted in an overall mean of 4.92 (*SD* = .71) across participants. Three Pearson correlations were conducted that revealed no significant correlations between Positive Social Affect and Surgency (*r* = .042, *ns*), Negative Affect (*r* = .098, *ns*), or Effortful Control (*r* = -.125, *ns*).

Secondary Analyses

Age and gender effects. Additional statistical analyses were run in order to determine whether demographic variables had a differential effect on any significant primary analyses, i.e. Positive Social Affect and Mullen Receptive Language. Age was not significantly correlated with Positive Social Affect (r = -.314, *ns*) or Mullen Receptive Language (r = -.163, *ns*). Gender (males, N = 20; females, N = 13) was also not significantly associated with Positive Social Affect (r = -.143, *ns*) or Mullen Receptive Language (r = .050, *ns*). Partial correlations were not necessary given the non-significant associations between demographic and significant clinical measures.

Social Attention. Additional correlations were run in order to determine whether social attention alone was related to any of the clinical measures. This analysis revealed no significant relationships between Social Attention and social-communication (Mullen Receptive Language: r = .206, *ns*; CSBS-CQ Social composite: r = -.018, *ns*), vocal production (CSBS-CQ Speech composite: r = -.323, p = .067), autism symptoms (AOSI Total: r = .068, *ns*), or temperament (IBQ-R Surgency: r = -.198; IBQ-R Negative Affect: r = -.014, *ns*; IBQ-R Effortful Control: r = -.117, *ns*).

Interrelations within clinical measures. Pearson bivariate correlations between all clinical measures were also conducted to determine how the clinical measures of infant behavior are related to each other. This analysis revealed significant relations between Mullen Receptive Language and the CSBS-CQ Social composite (r = .352, p = .044), CSBS-CQ Social composite and the CSBS-CQ Speech composite (r = .441, p = .010), AOSI total and IBQ-R Surgency (r = -.638, p<.001), as well as Surgency and Effortful Control (r = .543, p=.002). All correlations are reported in Table 6.

Table 6

Correlations Among All Clinical Measures

	Mullen Receptive Language	CSBS-CQ Social composite	CSBS-CQ Speech composite	AOSI Total	IBQ-R Surgency	IBQ-R Negative Affect
Mullen Receptive Language	.	.	.	.	.	.
CSBS-CQ[a] Social	.352*	.	.	.	.	.
CSBS-CQ[a] Speech	.157	.441*	.	.	.	.
AOSI[b] Total	-.293	-.301	-.031	.	.	.
IBQ-R[c] Surgency	.296	.266	.292	.638*	.	.
IBQ-R[c] Negative Affect	.108	.192	.229	.05	.037	.
IBQ-R[c] Effortful Control	.254	.278	.000	-.145	.543**	.174

* $p < .01$. ** $p < .05$.
[a] Communication and Symbolic Behavior Scales – Caregiver Questionnaire (CSBS-CQ). [b] Autism Observation Scale for Infants (AOSI). [c] Infant Behavior Questionnaire – Revised (IBQ-R).

Discussion

The primary aim of this study was to explore the clinical significance of positive social affect in typically developing 6-8-month-old infants so as to inform early identification of social communicative disabilities, especially autism spectrum disorder. Overall, results revealed a unique positive association between positive social affect and receptive language. No significant associations were observed with the parent report of social-communication or vocal production, clinical assessment of autism symptomology, or the three dimensions of temperament. These findings carry implications for early identification and intervention of ASD and warrant further exploration of the significance of social affect in infancy.

Diminished positive social affect, also termed social smiling, is a clinical characteristic of toddlers with ASD and has been hypothesized to constitute an early risk marker for ASD in infants as young as 6 months. This behavioral marker has been documented in infants older than 9 months, but studies with infants between 6-8 months have resulted in mixed findings. Despite several longitudinal studies investigating the predictability of an ASD diagnosis from early social-affective patterns, no studies to date have explored the significance of positive social affect as it relates to concurrent clinical measures. The current study sought to fill this gap in the literature by examining relations between positive social affect and social-communication, vocal production, autism symptomology, and temperament. Results of these analyses revealed that positive social affect is uniquely related to one component of social-communication: receptive language. However, it was not related to parent-reported behaviors of social-communication. This finding partially supports the original hypothesis that social-communication would be significantly related to positive social affect during structured parent-infant interactions. No significant relations were observed between positive social affect and vocal

production, autism symptomology, or temperament. As a whole, this suggests that an infant's display of positive affect with their caregiver during a purely social, dyadic interaction related to a measure of their receptive language ability. The measure of receptive language on the Mullen Scales of Early Learning for infants in the target age range of 6-8 months can also be conceptualized as general social responsivity. That is, infants who were more responsive to an examiner during tasks such as calling their name or reaching out to pick them up were more likely to be positively engaged during a face-to-face parent-child interaction. This result may suggest that positive social affect in early infancy is a meaningful indicator of receptive language, including social responsivity and perhaps social motivation. In contrast, all other clinical measures were not significantly related to positive social affect, including temperament. This differential relation may suggest that infant positive social affect during interactions with a caregiver is not a reflection of an infant's natural proclivity to exhibit more positive affect across settings, but rather a unique reflection of social-communicative ability, specifically social responsivity.

Positive Social Affect and Social-Communication

Positive social affect may be an indicator of an infant's ability to respond in a meaningful way to social initiations from an adult or caregiver. This unique relation allows for speculation regarding the underlying mechanisms of positive social affect during face-to-face interactions for 6-8-month-old infants. Two hypotheses are presented here.

Hypothesis 1: Positive social affect may be intentional communication. First, positive social affect could be an intentional expression meant to *communicate* joy and engagement with a caregiver. This would be an earlier analog of initiating joint attention in which infants at about 9 months of age begin to look to their mother and smile in order to communicate their internal state (e.g., joy, excitement, or surprise) regarding an

event. This would be consistent with Morales et al.'s (2000) study that individual differences in joint attention behaviors at 6 months are related to later language development as well as Parlade et al.'s (2009) study that infant smiling at 6 months is correlated with later joint attentional skills.

Hypothesis 2: Positive social affect may reflect social motivation. Alternatively, the construct shared by both receptive language and positive social affect could be social motivation. In other words, positive social affect may not be overtly communicative, but rather a positive response to social interaction and thus an indication of increased social motivation. The items on the receptive language domain require two skills: (1) understanding (the infant must understand the social bid initiated by the adult), and (2) responding (the infant must respond in a meaningful way). Children with ASD typically have more difficulty with receptive rather than expressive language on standardized tests, potentially due to diminished social motivation to respond rather than decreased capacity to understand (Koegel, Koegel, & Smith, 1997). In a similar way, it is possible that the measure of positive social affect used in this study could be tapping into the infant's motivation for social interaction. Infant language learning is facilitated by active social engagement, with the earliest language acquisition occurring in the context of social routines, such as feeding and singing (Kuhl, 2004; Tomasello, 2006). It is plausible that the infants who expressed more positive social affect during the lab-based experimental paradigm are generally more motivated to engage in social interactions at home, thus increasing their opportunities for language learning.

Direct assessment vs. parent report. The finding that the direct assessment of social-communication (Mullen Receptive Language) was related to positive social affect, but parent report (CSBS-CQ Social composite) was not, is worth discussion and further investigation. In terms of content, these two measures share similar items, such as the

infant's response to his or her name and reaching his or her arms to be lifted up. Yet the parent-report measure covers a much broader range of behavior including emotion regulation and some aspects of initiating communication, e.g. *"Does your child let you know that he/she needs help or wants an object out of reach?"* In this sense, the clinician-administered assessment is a more specific measure of infant responsivity to social-communication bids from an adult. Additionally, the Social composite of the CSBS-CQ takes into account frequency of behavior. Each item is rated on whether the infant engages in the activity often, sometimes, or not yet. This allows infants to receive credit for emerging skills that may have only been observed a few times in a comfortable, natural environment. The small, but significant correlation between these two measures supports the assertion that they share some similar constructs, yet are not interchangeable.

Research investigating concordance between parent-report and direct observation has reported significant agreement between these two methods of assessment, with assessments of expressive language having higher agreement than those of receptive language (Luyster, Kadlec, Carter, & Tager-Flusberg, 2008). Future research investigating social-communicative abilities in this age range should work to identify appropriate multi-method approaches to assessment that includes direct observation and parent-report measures.

Positive Social Affect is Independent of Vocal Production, Autism, and Temperament

As expected, positive social affect and vocal production were not significantly related. The measure assessing vocal production, CSBS-CQ Speech composite, covers an inventory of consonant and vowel sounds, as well as the type of sounds (e.g., single consonant-vowel sounds, canonical babbling). Although there are social-communicative elements to speech, such as imitating sounds, laughing, and crying, this measure only

evaluates the vocalizations heard by the parent. The finding that vocal production is unrelated to positive social affect is consistent with the autism literature in which adequate expressive language abilities are not always indicative of adequate social-communication (Ozonoff, Goodlin-Jones, & Solomon, 2005). In other words, children with ASD may exhibit average to above-average abilities in spoken language, but they are not using that language appropriately. For these children, expressive language is independent of their social-communication abilities.

Autism symptomology, measured with the AOSI, was also not associated with positive social affect. This finding was expected given the diagnostic nature of the measure as well as the wide range of behaviors assessed in the AOSI. Evaluation of autism symptomology for this age range is comprised of more than just social engagement, social responsivity, and social initiations. The AOSI includes non-social items such as visual disengagement, visual tracking, and atypical motor behaviors. The current evidence demonstrates that positive social affect is not related to this larger constellation of autism symptoms. Furthermore, the AOSI was developed as tool to differentiate high-risk infant siblings of children with ASD who go on to receive a diagnosis and those who do not (Bryson & Zwaigenbaum, 2014). It was not originally intended to be sensitive to typical variability in development, but rather to identify extremely abnormal behaviors that are risk factors for ASD. It would be more informative to assess this association in a population where autism symptoms are more prevalent, such as high-risk infant siblings of children with ASD. Finally, research shows that the AOSI is not a predictive measure of ASD for infants at 6 months (Brian et al., 2008), suggesting the AOSI simply may not be sensitive enough to measure autism symptoms at 6 months, especially in a sample of typically developing infants.

The finding that positive social affect and three dimensions of temperament are not related is especially illuminating. In this study, temperament was used as an index of variability in typical development. Temperament helps to account for infant's behavioral styles or "dispositional traits" (Nigg, 2006). Infants vary widely in behavioral style, for example how long they can sustain attention, enjoyment of highly stimulating activities, and generally how frequently and intensely they express positive or negative affect. These characteristics, however, do not (by themselves) indicate specific pathways to psychopathology. The lack of an association between positive social affect and temperament suggests that the amount of positive affect directed to a caregiver during face-to-face play is not simply a reflection of temperamental style, but rather a discrete measure of social-communicative functioning. This is partially consistent with studies with older toddlers showing that only the Negative Affect aspect of temperament is related to social-communicative abilities (Salley & Dixon, 2007). It is also partially inconsistent with Vaughn and colleagues' (2003) finding that positive emotional response to novelty and social approach (both components of Surgency) is related to the social-communicative behavior of initiating joint attention with an examiner at 9 months. However, infant performance during interactions with an unfamiliar adult may tap into the approach/withdrawal aspects of Surgency more effectively than a naturalistic interaction with a familiar caregiver. Future research emphasizing how temperament may differentially affect social-communication with a caregiver compared to that with an examiner will be critical to understanding these associations in infancy.

Secondary Analyses

Age and gender effects. In an exploration of how demographic variables may be related to significant findings in the primary analyses, age and gender were not found to be correlated with positive social affect or receptive language. This suggests that the

primary findings are applicable to all infants between 6-8 months regardless of age or gender.

Social attention without affect may be unimportant. Social attention was also explored as a possible correlate of all clinical measures. Social attention was defined as the total percent of time the infant looked to the face of the caregiver, regardless of the expressed affect. Results revealed that overall social attention was not associated with social-communication, autism symptomology, or temperament. Limited attention to social stimuli is a relevant marker of ASD in older toddlers and research is beginning to show its importance for infants as young as 6 months in structured eye-tracking paradigms (Jones & Klin, 2013; Chawarska, Macari, & Shic, 2013). However, this more macroscopic, naturalistic measure of social attention did not illuminate significant associations with concurrent clinical profiles in infancy.

Overall, there is little support for social attention during dyadic interaction as an indicator of social abilities or temperament. There is, however, support for the importance of affective expression in analysis of looking behaviors. That is to say that the amount of time an infant spends attending to the caregiver during social interactions is not clinically meaningful, but looking to the face with positive affect is an important behavioral feature in infancy. Certainly, difficulty with eye contact, regardless of facial expression, is a hallmark feature of older infants, toddlers, and children with ASD. However, this study is consistent with other literature reporting that social attention alone for infants younger than 9 months is not an indicator of social functioning or ASD.

Intercorrelations reveal effects of temperament. As a third exploratory analysis, intercorrelations among all clinical measures were explored. The associations between these measures in young infants have not yet been thoroughly explored and this analysis serves as a foundation for future research. First, it was found that the two measures of

social-communication were significantly, positively related, further supporting that these measures are both measuring similar, but not identical, constructs. As previously discussed, future research should explore concordance between parent-report and clinician-administered assessment to better understand the nature of this relation. Parent-report of social-communication was also significantly related to parent-report of infant vocal production. As both social-communication and vocal production follow a developmental trajectory, it is not surprising that infants further developed in social-communication are also more advanced in their speech development, especially in a typically developing sample.

The AOSI total score and Surgency dimension of the IBQ were significantly, negatively related. This was the largest effect of any of the primary or secondary findings (r = -.638). First, it should be noted that a higher score on the AOSI indicates more autism symptoms and therefore more atypicality. A higher score on the Surgency dimension indicates higher positive emotionality and approach across a variety of contexts. This relation indicates that infants who exhibit more positive affect and are more likely to approach novel situations obtain lower scores on the AOSI (i.e., they show less autism symptoms). Several items on the AOSI address behaviors related to social engagement with the examiner, including eye contact, social anticipation, reciprocal babbling, and social interest. Given the limited social-communicative skillset in infants this young, it is possible that temperament has more of an effect on how they socially interact with an unfamiliar examiner than their social abilities, a notion consistent with Vaughn et al.'s (2003) study of joint attention and temperament in infancy. Note that this is in contrast with the behavioral measure of positive social affect, which was related to receptive language but not temperament. This finding suggests that scores on the AOSI in a sample of typically developing 6-8-month-old infants is a reflection of temperament, while

percent time engaged in positive social affect is a reflection of social-communication. To the author's knowledge, this is the first study to investigate concurrent relations between AOSI scores and temperamental profiles in 6-8-month-old infants. Finally, a significant association was observed between the Surgency and Effortful Control dimensions of the IBQ, a finding consistent with the original development of the instrument (Putnam, Ellis, & Rothbart, 2001).

Limitations

There are several limitations to this study that warrant further investigation, and replication of the conclusions and conjectures explored in the present discussion. First, this study should be replicated with a larger sample of infants to increase statistical power. Additionally, the racial/ethnic diversity of the current sample was extremely limited. It would be important to investigate cultural differences in a sample of more demographically diverse infants. Second, this study was not longitudinal in nature and therefore did not explore the predictive value of positive social affect for later developmental outcomes. A longitudinal study following infants throughout early development would shed light onto meaningful differences between concurrent clinical correlates of positive social affect and its utility as a predictor of later-developing clinical features. Further, it would be interesting to utilize this experimental paradigm in a sample of high-risk infant siblings to observe differences in infants with a genetic predisposition for developing ASD and low-risk infants.

Limitations also exist in the measures that were used for this study. Although there were four clinical measures used, several additional measures exist to evaluate infant behavior. For example, nonverbal cognitive measures, such as the Visual Reception, Fine Motor, and Gross Motor domains of the Mullen Scales of Early Learning may have added to our understanding of the variability in positive social affect. Additionally, the version of

the temperament questionnaire that was used for this study was the Very Short Form. A longer version of the IBQ would provide a richer picture of the infants' temperamental profile. Finally, although the AOSI includes items related to social engagement, other clinician-administered measures of infant social-communication, such as the Early Social Communication Scales (ESCS; Mundy et al., 2003), could provide a more fine-grained inventory of the infants' current abilities. These and other similar measures should be included in future studies investigating positive social affect in infancy.

Implications for Early Identification

The primary aim of this study was to better understand early social development in order to inform early identification of ASD and intervention efforts. Limited positive social affect during structured parent-infant interactions has long-been a clinical concern for researchers, clinicians, and parents. This study identified positive social affect as a meaningful indicator of social responsivity and potentially social motivation, but not temperamental style in early infancy. This does not imply that diminished positive social affect in infancy is indicative of autism or any other disability, but it confirms that infants with lower positive social affect are less socially responsive than their more highly engaged peers. Importantly, it also suggests that infants who exhibit low positive social affect should not be dismissed as infants who are temperamentally "shy" or "serious," but rather infants who may be struggling with social responsivity and language development. So although this study does not suggest that low positive social affect is a red flag for autism, it does propose that it may be a behavioral marker of low social responsivity. Additional research in this area with larger sample sizes, atypical populations, and a longitudinal design, would help to better understand positive social affect as a potential prodromal symptom of ASD and whether this behavioral marker in infancy warrants early intervention.

Implications for Treatment

Ultimately early identification efforts should result in development of early intervention and prevention strategies. The analyses conducted in this study do not allow us to disentangle the directionality of the relation between low positive social affect and low receptive language. Therefore, if low positive social affect is a behavior that warrants early intervention, it is unclear whether it would be most beneficial to target social affect or receptive language. In a recent study targeting early social engagement for young infants, Koegel et al. (2014) developed a behavioral intervention to increase positive affect during parent-infant interactions. This study showed that the intervention was successful in increasing infant positive affect, but the lack of additional clinical measures makes it difficult to establish efficacy of the intervention for improving other social-communicative and diagnostic outcomes. A promising next step would be to study the effects of increasing infant positive social affect across a variety of developmental and social-communicative domains, including diagnostic outcome.

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