SHARED POSITIVE AFFECT: AN EARLY BEHAVIORAL RISK MARKER FOR AUTISM SPECTRUM DISORDERS?

By

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CHAPTER I

LITERATURE REVIEW

Social-emotional development is a critically important domain to consider in the study of overall health and growth of children and it is also an important area to examine when development goes awry. Social-emotional skills begin to develop right from birth (if not earlier) and affect not only later interpersonal relationships and emotional health, but may also impact other areas of development, such as cognitive and language functioning. The following review will focus on a specific social-emotional behavior that is known to be important in typical development: shared positive affect. The role of this behavioral construct in typical development and its potential applications to early screening for autism spectrum disorders is discussed.

Shared positive affect refers to the social use of positive emotional expressions (e.g., smiling). Operationally, shared positive affect involves the two discrete, observable behaviors of eye contact and smiling, which are coordinated into a unified act. Expanding these two components, one can argue that positive affect sharing involves two broader constructs of social attention and emotion/affect. Within the social attention domain, positive affect sharing may include visual attention to and preference for human faces, eye gaze patterns (i.e., gaze aversion vs. attention to objects vs. attention to persons) and social orienting and responsiveness (e.g., responding to name). The emotional/affective component may broadly include temperament characteristics (i.e., inherent tendency toward negative or positive affect), emotional arousal (i.e., hypo- vs.

hypersensitive) and regulation (i.e., synchrony vs. dysregulation), and emotional expression and comprehension.

It is well established in the child development literature that typically developing infants readily display the capacity for these fundamental social-emotional skills beginning at very early ages. For example, research indicates that the human face is a social stimulus shown to be consistently preferred and interesting to young infants. Very early on, babies choose to look at faces of people over other stimuli (Fantz,1961, 1966) and are able to discriminate between face-like and other patterns just minutes after birth (Johnson & Morton, 1991). These findings lead some to believe that "faces are special" and that human infants are innately predisposed to respond to faces. It makes biological and evolutionary sense that human faces would be designed to attract the attention of babies, "because faces are a vital source of information for social and emotional relationships" (Bukatko & Daehler, 2001, p. 204).

Social-Emotional Development within Early Dyadic Interactions

The earliest social interactions often occur between the infant and caregiver at the face-to-face level. Human infants are biologically designed for the physical closeness that sets the stage for interpersonal relationships and social-emotional development. Newborns' visual acuity is optimal at a distance of 8-20 inches away, the typical distance between the baby in his mother's arms and the mother's face (Bukatko & Daehler, 2001). It is primarily within this early dyadic context that the baby will develop the foundational skills for healthy social-emotional development. For example, the work of several researchers has suggested that newborn infants are capable of imitating adult facial expressions associated with the basic emotions of happiness, sadness, and surprise (Field et al., 1982; Field et al., 1983; Meltzoff & Moore, 1977, 1983; Reissland, 1988). Interestingly, research has shown that these neonatal imitations occur most frequently during reciprocal face-to-face interactions when the adult participant is engaged with and attuned to the infants' cues; in contrast, they are difficult to elicit during highly controlled, pre-determined sequences of actions that do not support mutual engagement and interaction between the social partners (Kugiumutzakis, 1993).

Through the experience of reciprocal dyadic interactions with their caregivers, infants learn to regulate their emotions, to use their affective displays for purposeful communication, and to develop their skills for social interpersonal relationships. The reciprocal exchanges that occur between the infant-adult dyad are driven by the goal of achieving social engagement and provide an initial context for developing mutual regulation of behavior (Tronick, 1982). Episodes of interactive synchrony in which the child and the caregiver engage in mutually contingent behaviors characterize a large portion of face-to-face interactions in the child's first year of life (Tronick & Cohn, 1989). Patterns of mutual gazing, vocalizing, smiling, and touching one another, are often observed between the adult and infant in these early dyadic exchanges (Tomasello et al., 2005), which Trevarthen (1979) refers to as "primary intersubjectivity." The regular occurrence of these exchanges and repeated success in reaching the objective of social connection between partners provide a foundation upon which normal social, emotional, and communicative development is based.

Importantly, it appears that a crucial factor in maintaining the face-to-face turn-taking interactions is the exchange of emotion between partners (Hobson, 2002; Stern, 1985; Trevarthen, 1979). It has been argued that emotions are inextricably linked with the social environment (Campos et al., 1994; Saarni, 1999) and that the affective system is the principal mode used to initiate, maintain, and terminate joint exchanges (Bretherton et al., 1986; Tronick, 1982). The back-and-forth nature of the early dyadic reciprocal interchanges has been likened to a choreographed dance in which each partner reads each other's cues to determine how to proceed so that the end result is coordinated, smooth, and enjoyable (Bukatko & Daehler, 2001). In the early face-to-face social-emotional exchanges both partners provide affective cues to one another to regulate the interaction, which has been described as affect attunement (Stern, 1985).

The Role of Shared Positive Affect in Dyadic Interactions and the Development of Social Smiling

The development of coordinated, or shared positive affect between social interactive partners seems to be particularly salient during early dyadic interactions. Trevarthen (1979) noted that the experience of shared equilibrium in early communication is "signaled by reciprocal smiling" (Reddy et al., 1997, p.250). Socially engaged, mutually regulated interactions between an infant and an adult often result in the sharing of positive affect (Field, 1990; Tronick, 1982). Thus, as these reciprocal interactions form a substantial part of the infant's earliest social experiences, infants will also be primarily exposed to positive affective expressions. Malatesta and Haviland (1982) reported that 3- to 6-month old infants rarely or never saw negative or fearful expressions displayed on their mothers' faces during face-to-face interactions.

Infants make rapid development in their own ability to express and share positive affect in the first year of life. Smiling is reported to be one of the most commonly observed social behaviors during the first 6 months of life (Kaye and Fogel, 1980; Weinberg and Tronick, 1994; Yale et al., 2003). Initially, neonates smile when they experience changes in internal state or physiological arousal (Messinger et al., 2002; Wolff, 1987). Around 2 weeks of age, infants begin to show more distinct recognizable smiling, characterized by the familiar curling up of the lips, contracting of the cheek muscles, and squinting of the eyes (Messinger, Fogel, & Dickson, 1999). By 2½ to 3 months of age, infants become more obviously social as they smile more in the presence of social stimuli, usually their mother's face (Adamson & Bakeman, 1985; Fogel, 1982). At this point, babies are able to consistently maintain eye contact during face-to-face interactions (Reddy et al., 1997) and to regularly coordinate eye contact with vocalizations and facial expressions (Yale et al., 2003). The "social smile" emerges during this stage of development and is considered to be an important milestone because of the primary role smiling plays in initiating and maintaining early social interactions (Bukatko & Daehler, 2001).

In sum, early in the first year of life, typically developing infants frequently experience face-to-face dyadic social interactions, usually with their primary caregiver. Importantly, the sharing of emotion appears to be a key component for ensuring the success of these early interactions. Successful dyadic interactions are characterized by synchrony, attunement, and shared positive affect. The repeated occurrence and experience of these coordinated, reciprocal social interactions helps infants learn to regulate their emotions and communicate their intentions, thus laying the foundation for healthy social-emotional development later in life. Many researchers and theorists who study typical child development argue that the early dyadic interactions between adults and infants necessarily precede and underlie the development of later, more complex triadic interactions (Bakeman & Adamson, 1984; Bruner, 1975; Reddy, 2001; Striano & Rochat, 1999; Trevarthen & Hubley, 1978; Tronick, 1982; Vygotsky, 1978).

Triadic Interactions and Joint Attention

In typical development, infants around 5-6 months of age begin to switch the focus of their attention from primarily social face-to-face interactions to increased interest in physical objects, possibly resulting from the developmental maturation and coordination of the infant's motor, visual-perceptual, or neurological systems (Fogel, `1993; Messer, 1997; Schaffer, 1984). Between 9 and 15 months of age, infants become better able to coordinate smiles, eye contact, and gestures for social-communication and thus, they begin to engage in triadic activities in which the social and physical worlds become coordinated (Carpenter et al., 1998; Messinger & Fogel, 1998). Bakeman and Adamson (1984) noticed a developmental trend from 6 to 18 months of age in which infants gradually decreased in their amount of one-on-one person play, or dyadic interaction, and increased the amount of time they spent engaged in "joint engagement," or triadic interaction. This form of interaction introduces a third external event or object into the social situation and is referred to as secondary intersubjectivity, or more commonly as joint attention (Carpenter et al., 1998).

Broadly, triadic activities may include anything involving two people attending to or interacting with the same object, from giving toys to one another, to rolling a ball back and forth, to cooperatively building a tower of blocks. Joint attention behaviors may be observed during triadic interactions and have been defined in a variety of ways by different researchers. For the purposes of this discussion, I will use the definition of joint attention as a communicative act that occurs for the purpose of sharing attention, following attention, and/or directing attention to some third external object or event (Carpenter et al., 1998; Sigman & Kasari, 1995). Triadic interactions or situations will be used as an umbrella phrase to cover any situation involving a child, an adult, and one or more objects (during which joint attention may, but will not necessarily be observed).

The Role of Emotion and Positive Affect Sharing within Triadic Interactions

The social context within which triadic interactions occur can impact both the quantity and quality of the social and affective behaviors observed during those interactions. Many communicative behaviors observed during these interactions may take the same overt form, but be used for different reasons. For example, a child may point to request the cookie out of reach or to direct his mother's attention to the plane flying overhead; a child might look back and forth between his father and a large dog to check if it is safe or to share the fun experience.

The social-emotional motive for using communicative gestures during joint attention differs from the instrumental purpose of using those gestures during requesting acts; the latter are used to elicit help in attaining some desired object or event. The purpose and function of using communicative behaviors for joint attention is to share one's experience of some object or event with another person (Mundy, Kasari, & Sigman, 1992; Rheingold, Hay, & West, 1976). In other words, joint attention involves socially motivated communicative acts.

Adamson and Bakeman (1985) point out that the context of social interchange that is present during joint attention is a prime condition for affective exchange. Furthermore, as the ability to use referential communication in triadic interaction develops, affective displays are no longer the "topic of conversation" as they were during face-to-face dyadic interactions, but rather "the object world provides the central theme and affective signals provide a means to 'comment' on this theme" (Adamson & Bakeman, 1985, p. 591). It is well documented in the literature on child development that episodes of joint attention are often "marked by vivid affect on the faces of the infant and social partner" (Sigman & Kasari, 1995, p.190). It has been suggested that affective expression itself may be a key factor in distinguishing whether certain behaviors are used for the communicative purpose of joint attention or requesting (Bruner, 1981, 1982).

A study of 20-month-old typically developing children examined the combination of affect with behaviors used for joint attention or requesting (Mundy, Kasari, & Sigman, 1992). Positive affective displays directed to the experimenter's face were coded alongside the time of occurrence of communicative acts. Typical infants were found to display significantly more positive affect associated with joint attention than requesting acts. These authors stated that, "In so far as joint attention behaviors provide indices of the infants' developing tendency to share affective components of subjective experience vis-à-vis an object, measures of these behaviors may provide an operationalization of one aspect of intersubjectivity (p.380)."

Some researchers suggest that, in addition to the tendency for shared social smiling to co-occur with instances of joint attention, the inherent propensity for infants to share positive affect may actually influence the development of joint attention skills

(Adamson & Bakeman, 1985; Kasari, Sigman, Mundy, & Yirmiya, 1990; Mundy, Kasari, & Sigman, 1992; Vaughan et al., 2003). In this respect, aspects of infant temperament, such as emotional reactivity, may be related to joint attention development (Adamson & Bakeman, 1985; Mundy & Willoughby, 1998; Trevarthen & Aitken, 2001; Vaughan et al., 2003). This theory posits that individual differences in infant temperament styles, such as level of excitability and sociability, affective responses to novelty, and approach behaviors, may promote later developmental differences in joint attention skills (Mundy & Willoughby, 1998). For example, Vaughan and colleagues (2003) found that 9-month-old infants who were rated as having a "positive emotional response to novelty and a tendency toward social approach" were more likely to initiate joint attention with examiners during a standardized interaction procedure, though this tendency toward positive affect was not found to relate to infants' responses to joint attention bids.

Taken together, these studies show that typically developing infants make important gains in social-emotional development in the first two-years of life. They learn to respond to and initiate affective cues, and they develop the ability to coordinate verbal, nonverbal, and emotional behaviors to regulate social interactions. Positive affect sharing is a critical component of early dyadic and triadic interactions and also shows important developments through the first 2 years of life. In fact, a tendency toward positive affect sharing may actually promote the development of certain later social, emotional, and communicative skills (e.g., initiating joint attention), though much of the current research on this topic remains theoretically rather than empirically based.

Autism: A Special Case for the Study of Early Social-Emotional Development

Autism is a disorder that may provide particularly important information about early disturbances to social-emotional development. For children with autism, the experience of social interaction and social-emotional development appears to be vitally different from that of other children. From its earliest description, autism has been characterized as a disorder in which children have a fundamental inability to relate to others (Kanner, 1943). Autism-related difficulties in initiating social interactions, responding to social bids, using eye gaze, and sharing affect reduce the likelihood that they will actively seek out the attention of others, which often limits their opportunities for social involvement and interaction and can negatively impact the young child's ability to engage in the highly coordinated, reciprocal social exchanges that most infants experience on a regular basis in the first months of life (Kasari, Sigman, & Yirmiya, 1993).

As autism is usually not diagnosed until the preschool years, little research has been done specifically examining the early face-to-face dyadic social interactions of infants with ASD. One study (Wimpory et al., 2000) used parental interviews to examine social engagement retrospectively in early "person-to-person" dyadic interactions as well as "person-person-object" triadic interactions. Their results suggested that, in addition to well established autism-related impairments in joint attention, infants who have autism also show impairments in dyadic social relatedness, including "sociability in play," "enjoying lap games," and "frequency and intensity of eye contact" compared to infants with non-autistic developmental delays. These authors concluded that their results support the theory that young children with autism have "impairments in primary [dyadic] as well as secondary [triadic] intersubjectivity" (p.525). Though this study used questions related to eye contact, temperament (i.e., soothability), general positivity during social games and interactions, and socially directed feelings of negative affect (i.e., anger and distress), social smiling or socially directed positive affect was not specifically addressed.

Impaired Social Orienting and Attention in Children with Autism

One of the earliest observable aspects of social interest and relatedness is the way in which children look at other people. Impairments in the use of eye-to-eye gaze (i.e., social attention) have been found for children with autism during unstructured play situations (Kasari, Sigman, & Yirmiya, 1993) and parents of children with autism often report abnormal use of eye contact (Volkmar, Cohen, & Paul, 1986). The ability and/or motivation to look to others, and particularly to look at another person's face, is an essential first step toward recognizing affective expression and sharing an emotional experience with that person. Twenty-month-old toddlers with autism have been shown to spend less time looking at people and more time looking at objects compared to toddlers with developmental delay or typical development (Swettenham et al., 1998).

In addition to early abnormalities in eye contact, children with autism have also been shown to have a fundamental deficit in orienting to social stimuli. One study (Dawson et al., 1998) demonstrated that 5-year-old children with autism showed a general orienting deficit compared to controls with Down syndrome or typical development, with a particular impairment in responding to familiar, naturalistic auditory social stimuli, such as their name being called or hands clapping. Children with autism were significantly less likely to orient to the social cue, and those who did respond tended to show a delay in their responses. This deficit in social orienting was also found to be significantly related to a concurrent measure of joint attention ability. Similar findings have been extended to younger preschool aged children with autism (Dawson et al., 2004; Leekam, Lopez, & Moore, 2000) and to studies examining a wider variety of social stimuli (i.e., including non-vocal touch or visual attention-getting bids in addition to vocal auditory cues) (Leekam & Ramsden, 2006).

Atypical Emotional Development in Children with Autism

In addition to their impairments in social attention and orienting, children with autism also differ from other children in their emotional skills. Both atypical affective responsivity and spontaneous affective expression for children with autism have been demonstrated (Loveland et al., 1994). Individuals with autism "display fewer facial and gestural expressions of emotion, especially expressions of positive affect" (Yirmiya et al., 1989, p.726). Children with autism are often described as being emotionally flat and have been shown to display less positive affect than other children when interacting with others (Bieberich & Morgan, 1998). For example, Yirmiya and colleagues (1989) found that children with autism displayed less positive affect and more neutral expressions when compared to children with typical development and those with mental retardation. These researchers also observed that the children with autism showed a wider variety of affective expressions compared to controls, including negative and incongruous blends of emotional expression that were not displayed by any of the children in the normal or mentally retarded groups. Similarly, other researchers have described individuals with autism as showing more “bizarre” or “mechanical” emotional expressions compared to individuals with Down syndrome (Loveland et al., 1994).

Impaired Positive Affect Sharing During Early Social Interactions

Given their impairments in social attention and emotional expressivity, the coordination of these behaviors for the social sharing of positive affect may be particularly difficult for children with autism. Interestingly, it seems that children with autism do not always differ from control groups in absolute levels of positive affective expression, but rather the difference appears to lie in the sharing of positive affect in a social context (Stone, 1997). Research has indicated that it may not be expression of emotion itself that is deficient in children with autism, but that the deficiency may be in the social-cognitive skills needed to help these children determine the appropriate use of such expression (Kasari, Sigman, & Yirmiya, 1993).

Dawson and colleagues (1990) examined the social interaction, attentional, and affective behaviors of young children with autism and typically developing children across different social-communicative contexts. As part of this study, eye gaze and affective expression were coded during a snack time routine in which mothers and children were engaged in face-to-face interaction. Results indicated that children with autism and typical development did not differ in the overall frequency and duration of smiling during the face-to-face interaction condition. However, children with autism were much less likely than children with typical development to combine their smiles with gaze at their mothers’ faces. Children with autism were significantly less likely than typically developing children to smile in response to their mothers’ smiles and tended to show more spontaneous, non-communicative smiles than normal children. These authors concluded that children with autism demonstrate a qualitative deficiency in their use of eye contact and affect in that they appear impaired in their ability to appropriately combine both into a unified, communicative act.

Another study (Trad, Bernstein, Shapiro, & Hertzig, 1993) further demonstrated impairments in social responsivity and emotional expression for children on the autism spectrum. Affective and behavioral responsiveness was examined on two dimensions: Attention to Persons and Attention to Things. Children with a PDD diagnosis (according to DSM-III criteria) were compared to children with developmental delay or mental retardation from observations of free-play sessions. Results indicated that PDD subjects appeared more impaired in affective responsiveness during interaction with their mothers compared to controls. Positive affect was significantly less correlated with concurrent attention to the mother for PDD subjects than for controls. No significant group differences were found in affective responsiveness to objects. From these results, the authors concluded that the affective deviations of PDD subjects may be specific to social-interpersonal interactions.

In summary, children with autism show deficits in early social skills, including eye contact and emotional expression, compared to other children, including children with global developmental or cognitive delays. Importantly, these impairments appear most pronounced during social interactions, such as the face-to-face routines that characterize many of the early exchanges between infants and their caregivers. The difficulties that children with autism have at this level of social development can affect both the quantity and the quality of social interactions they will experience throughout development. As noted previously, early dyadic interactions experienced by typically developing infants are thought to provide the early foundation from which later, more complex triadic interactions develop. Researchers have demonstrated that children with autism have attentional and affective difficulties at both the dyadic and triadic levels of interaction.

Impaired Affect Sharing in Triadic Joint Attention Interactions

Impairments in triadic interactions, particularly in the use of joint attention behaviors, are often noted to be a specific characteristic of young children with autism spectrum disorders. Joint attention ability has been found to discriminate children with autism from those with other developmental delays or typical development (Charman, 2003; Charman et al., 1998; Dawson et al., 1998; Mundy et al., 1986; Stone et al., 1997). Children with autism both initiate and respond to joint attention bids less often than typically developing or developmentally delayed children (see Bruinsma et al., 2004 for a review). Multiple studies have shown that children with autism often do not initiate acts of joint attention by holding up objects for others to see, bringing objects to other people, or pointing out objects to others for the sole purpose of sharing interest as often as do typically developing children or children with other developmental delays (Sigman et al., 1986; Stone et al., 1997; Wetherby et al., 1998). Additionally, children with autism show impairments in their ability to respond to the verbal and nonverbal (i.e., shifting eye gaze, head turn, pointing) cues that others use when trying to direct the attention of the child to an item of interest in the shared environment (Sigman et al., 1986; Stone et al., 1997; Wetherby et al., 1998).

In typical development, it is generally accepted that joint attention skills and sharing of positive affect are inextricably related. Thus, it may be that the deficits in both of these areas that are seen in autism may also be related. One suggested relation is that the specific deficit in communicating for the purpose of joint attention that is seen in children with autism is a direct result of a more fundamental impairment in their ability to be emotionally connected with others (Hobson, 1989, 1993).

Kasari, Sigman, Mundy, & Yirmiya (1990) compared the affect and attentional focus of children with autism, mental retardation (MR), and typical development during the Early Social-Communication Scales (ESCS) (Mundy, Hogan, & Doehring, 1996; Seibert, Hogan, & Mundy, 1982). Results revealed that, compared to the other groups, the autism group spent the most time unfocused on either the objects or the adult's face. The children with autism also used significantly fewer communicative behaviors overall, for either requesting or joint attention, than children in both of the comparison groups. Additionally, children with autism displayed less positive affect than the normative sample during joint attention acts and their displays of positive affect did not differ between joint attention and requesting situations. In summary, the children with autism displayed low levels of positive affect overall and were particularly impaired in their tendency to share affect for the purpose of sharing their experiences (i.e., joint attention).

Snow, Hertzig, and Shapiro (1987) examined the spontaneous affective expression of young children with autism or developmental delay in a free-play social context. Children with autism were found to display significantly less positive affect than the developmentally delayed controls. Notably however, it was not the case that children with autism were less emotionally expressive overall, but their positive affective expression showed a different pattern of relation to the interpersonal context compared to that of the developmentally delayed group. The children with autism displayed significantly more positive affect than controls in the unrelated and independent play conditions, whereas children with developmental delay displayed significantly more interactive, partner-related (i.e., socially shared) positive affect than children in the autism group. This study supports the idea that children with autism deviate from other populations in their spontaneous sharing of positive affect in unstructured social settings.

Overall, the studies reviewed in this section show that children with autism are impaired in their capacity and/or motivation to engage in triadic interactions compared to other children. However, it appears that children with autism particularly lack joint attention skills, but their ability to use requesting behaviors may be somewhat better developed. In other words, they have difficulty with those triadic interactions for which the purpose of communication is socially motivated and often involves the sharing of positive affect. Though these studies have shown joint attention behaviors and the sharing of positive affect to be related, the causal relation between these constructs is still unknown.

The Role of Shared Positive Affect in Early Screening For Autism

Despite advancements in the early diagnosis of autism in recent years, children with autism still often do not receive a formal diagnosis until age 3 or 4 (Filipek et al., 2000; Gupta et al., 2007), though parents often report development concerns by 18 months of age (Coonrod & Stone, 2004; DeGiacomo & Fombonne, 1998; Young, Brewer, & Pattison, 2003). Over the past decade, there has been a growing force in the autism literature to gain a better understanding of early developmental markers of autism and to develop better tools for early screening and diagnosis, which led the American Academy of Pediatrics, among others, to publish guidelines and clinical practice parameters recommending that all 18 to 24-month-olds be screened for autism (American Academy of Pediatrics, 2006; Filipek et al., 2000; Johnson & Myers, 2007; Zwaigenbaum et al., 2009. In examining which of the core symptoms of autism should be investigated in the search for early markers of autism, social-emotional skills may be a critically important area to investigate. Though language, restricted interests, and stereotyped motor behaviors are diagnostic symptoms of autism, they are often not the first ones seen in autism (Short & Schopler, 1988; Stone et al., 1994). Social deficits are generally considered to be the most pronounced and consistent characteristic of young children with autism (Stone et al., 1999; Wimpory et al., 2000), and thus may be a particularly good area of development on which to focus the search for early risk markers for autism. Many of the social symptoms that are well-established characteristics of preschool-aged children with autism (e.g., impaired eye contact, shared affect, social orienting, imitation, joint attention) could theoretically be observed earlier in infancy (Dawson et al., 2004). Some have argued that "early risk markers may not be simple analogues of later signs of autism, but rather behaviors that reduce the child's opportunities to learn from social experiences, thus initiating an atypical pattern of development that eventually leads to further manifestations of autism" (Zwaigenbaum et al., 2005, p.144).

To date, the primary methods used to study the very early development of autism have included retrospective analysis of home video tapes as well as prospectively following infants at increased risk for autism, due to failing early screening measures or having an older sibling with autism. In reviewing this literature, it quickly becomes evident that positive affect sharing and related behaviors such as eye contact, social orienting, dyadic interaction, joint attention, emotional expressions, and temperament are often implicated in these studies as being potential indicators of risk for receiving a diagnosis of an autism spectrum disorder (ASD).

Retrospective Analyses-Observations of Early Home Videos

Several examinations of early home videos have been reported for children who receive later diagnoses of autism spectrum disorders. Although these retrospective analyses are limited by unstandardized settings and observations, they have provided rich descriptions of early behaviors and have given researchers an idea of where to begin the search for early markers of autism. For example, Trevarthen and Daniel (2005) reported detailed findings from a case study in which they examined early home video of interactions between a father and each of his 11-month-old twin girls, one of whom received a later diagnosis of autism. In contrast to her typically developing twin, the child who developed autism showed very little eye contact with her father, and little coherent mutual engagement (i.e., no anticipation of the father's approaches and no emotional build-up). Additionally, it was noted that, though she displayed fleeting moments of positive emotional expressions, these were usually observed in response to some form of "physical stimulation from the father's actions on the baby's body" rather than as "anticipated intersubjective events" (p.S29). These authors concluded that "the evidence from detailed descriptive studies of children developing autism" suggests "that a neuro-developmental disorder is likely to show subtle signs very early" (2005, p.S32).

Several studies have attempted to address the limitations of retrospective home-video analyses by standardizing the observation context (i.e., same age and similar setting in children's first birthday parties) (Osterling & Dawson, 1994; Osterling et al., 2002) or by using control groups of children with mental retardation to examine early behavioral markers that are specific to autism rather than related to general developmental delays (Baranek, 1999; Clifford et al., 2007). These studies often report relatively consistent results and suggest that early behavioral markers of autism can often be reliably observed by the child's first birthday. Multiple studies report similar observations of social-emotional difficulties in infants who are later diagnosed with ASD. In the first year of life, the most commonly observed behavioral patterns are characterized by a combination of poor social attention (i.e., withdrawn/ignoring people, fleeting eye contact), poor social responsiveness and orienting (i.e., not responding to name), and atypical emotional expressivity (e.g., lack of social smiling, flat affect) (Adrien et al., 1993; Baranek, 1999; Maestro et al., 2005; Werner et al., 2000). Maestro et al. (2005) also reported that these symptoms of early social-emotional and social-communicative difficulties increased from 6 to 12 months of age and suggested that this period in infancy may represent a "special window" of opportunity for early diagnosis or screening of autism-related symptomatology.

Early difficulties in triadic joint attention have also been commonly observed in young children who develop autism. For example, Osterling and Dawson (1994) found that the specific behaviors of showing or pointing to objects in combination with looking to another person's face and orienting to one's name, correctly classified 91% of 12-month-olds with autism or typical development. However, comparing 12-month-olds with autism to those with developmental delays, Osterling and colleagues (2002) did not find joint attention ability to discriminate between these two groups, though both groups showed impaired joint attention skills compared to typically developing 1-year-olds. Instead, their results showed that the groups with autism and developmental delay could be discriminated on a measure of responding to name. This suggests that early measures of dyadic social orienting may provide a more specific early behavior for screening for autism than joint attention alone (Dawson et al., 2004), particularly at such young ages.

A recent article (Clifford et al., 2007) used video analysis to compare the early social characteristics of infants later diagnosed with autism (ASD), those with developmental delay or language delay (DD/LD), and typically developing infants (TD). Home videos that included recordings between the first and second birthdays were chosen to allow for observations of triadic social-communicative behaviors (i.e., joint attention and requesting). This study examined both quantitative and qualitative measures of early social behaviors, such as eye contact, gaze aversion, social smiling, social interest/approach, responding to name, affective positive and negative expression, joint attention behaviors, and play. Results showed that children in the ASD group could be distinguished from children in the DD/LD and TD groups on the basis of several dyadic-level social behaviors, including quality and frequency of eye contact, positive affect, gaze-aversion, response to name, interest in peers, participation in conventional social games (e.g., peek-a-boo), and social approach behaviors. Interestingly, the only triadic behavior that distinguished the ASD group from the other groups was protodeclarative showing. These authors aptly pointed out that the deficits they observed in positive affect and eye contact could underlie certain later-developing joint attention deficits. These findings support those of Osterling et al. (2002) in demonstrating the importance of investigating early dyadic behaviors in the development of autism. Additionally, these authors noted that the coordination of positive affect with eye contact (i.e., shared positive affect), which was not specifically examined in the current study, may be particularly important to examine as a precursor to later joint attention abilities.

The Prospective Study of At-Risk Infant Siblings of Children with ASD

Recent research has emphasized the prospective study of early behavioral markers of autism with high-risk samples. Infant siblings of children with autism offer a unique population from which the early development of ASD may be studied longitudinally and prospectively. Younger siblings of children with ASD (Sibs-ASD) are a very heterogeneous group that shows wide variation in developmental outcomes that can include having a diagnosis of an autism spectrum disorder, features of the broader autism phenotype (e.g., language or social delays), or typical development. The recurrence risk for ASD in Sibs-ASD is greater than rates seen in the general population and has been estimated to be between 6%-9% (Piven et al., 1997; Ritvo et al., 1989; Szatmari et al., 1998). The prevalence of the broader autism phenotype in siblings has been reported to be as high as 20% (Bolton et al., 1994).

Several recent studies have utilized the classic face-to-face/still-face (FFSF) paradigm (Tronick, 1982) to examine early social-emotional behaviors of Sibs-ASD. Results of these studies have been inconsistent. Cassel et al. (2007) found that, as a group, 6-month-old Sibs-ASD smiled significantly less overall during the FFSF procedures than the Sibs-TD, tending to smile less than Sibs-TD in the face-to-face portion of the FFSF paradigm and to show higher levels of neutral affect than Sibs-TD during the reunion period. In contrast, Yirmiya and colleagues (2006) found no group differences between 4-month-old Sibs-ASD and Sibs-TD on eye gaze or positive affect during the FFSF procedure. However, results from this latter study did indicate that 4-month-old Sibs-ASD showed weaker synchrony than Sibs-TD during dyadic interactions with their mothers when the infant initiated the interaction. Ibanez and colleagues (2008) examined visual attention and gazing patterns in 6-month-old infant siblings during the FFSF procedure. Results showed that Sibs-ASD did not differ from Sibs-TD on mean durations of gaze at the parent's face. However, Sibs-ASD were found to have longer mean durations of gaze away from that parents' faces and to shift their gaze less frequently than Sibs-TD. These results were interpreted as representing developing difficulties in disengagement of visual attention related to the characteristic "sticky" attention found in children with ASD. Yet another study examined eye tracking data on 6-month-old infant visual fixation patterns in Sibs-ASD and Sibs-TD during the FFSF paradigm (Merin et al., 2007). Results from this study revealed no group differences in overall levels of distress or visual fixation patterns to the face. However, a subgroup of at-risk Sibs-ASD demonstrated a pattern of reduced gaze to the mother's eyes and increased gaze to mothers' mouths.

A few of these studies also compared performance during the FFSF procedure to later social-communicative behaviors during the ESCS (Mundy, Hogan, & Doehring, 1996; Seibert, Hogan, & Mundy, 1982), again with inconsistent findings. Cassel et al.

(2007) found that, as a group, Sibs-ASD demonstrated fewer requesting acts at 12 months, fewer initiating joint attention (IJA) acts at 15 months of age, and fewer responses to joint attention (RJA) at 18 months of age than Sibs-TD. However, no significant correlations between early social-affective behaviors during the FFSF and later social-communicative behaviors on the ESCS were found for either group. In contrast, Yirmiya et al. (2006) reported that greater neutral affect at 4 months was correlated with lower levels of IJA at 14 months and that those Sibs-ASD infants who did not respond to their name at 4 months initiated significantly fewer requesting acts on the ESCS at 14 months.

In addition to studies assessing infant dyadic behaviors during the FFSF procedure, a few studies have also examined triadic behaviors, particularly joint attention skills, in at-risk infant siblings. Sullivan and colleagues (2007) examined response to joint attention (RJA) behaviors in Sibs-ASD at 14 months and 24 months of age. Results indicated that Sibs-ASD who went on to receive a diagnosis of ASD or were classified as having features of the broader autism phenotype (BAP) showed less RJA at 14 months of age compared to non-ASD or BAP siblings. Similarly, Presmanes et al. (2007) found that a group of Sibs-ASD showed less responding to joint attention cues than a comparison group of Sibs-TD. Furthermore, Sullivan et al. (2007) demonstrated that Sibs-ASD that were later diagnosed with ASD showed minimal progress in RJA performance from 14 to 24 months of age compared to the other sibling subgroups and RJA skills at 14 months predicted later language skills and ASD outcome.

Despite some inconsistencies in these reports, overall these studies do suggest that Sibs-ASD may be at risk for subtle social-emotional differences at very early ages that could put them on a developmental trajectory toward later, more pervasive difficulties. Future prospective research is needed to better understand how early emotional behaviors may relate to later social-communicative skills in younger siblings of children with ASD, as this developmental relation is widely accepted in the typical child development literature. Furthermore, these studies did not specifically measure the coordination of eye gaze with positive affect (i.e., shared positive affect) and several of the studies included participants that were too young to receive diagnostic testing, thus outcome diagnoses were not available. It is possible that differences in eye gaze, positive affect, and/or shared positive affect could emerge when comparing Sibs-ASD who go on to receive a formal ASD diagnosis to those who do not.

A few studies have contributed rich qualitative descriptions of the behaviors of infant Sibs-ASD. Dawson et al. (2000) reported detailed observations of a child whose development was closely monitored from birth and who received a diagnosis of autism at age 2. During the first 6 months of life, this child's social-affective development was described as appearing relatively normal, with good eye contact, social responsiveness, and social smiling. By 9 months, however, unusual eye contact was described as being a "transfixed stare" and the child was not observed to engage in socially imitative play. At the 1-year well-baby visit, this child was described as having "diminished social responsiveness" that included inconsistent eye contact, gaze aversion, and lack of responsive smiling. By 15 months of age, parent report indicated several significant concerns in the social domain, including failure to use direct gaze, to engage in social smiling, to use a range of facial expressions, to seek to share own enjoyment with others, and to regulate social interaction. During free play with his mother, this child was observed to avoid interaction and eye contact, to fail to make social overtures or share his interest in toys with his mother, and to only smile and laugh during a physically stimulating game. He was also noted to fail to initiate or respond to joint attention behaviors on the ESCS and to show inconsistent orienting to social stimuli. By 2 years of age, the child met full diagnostic criteria for autism. At this time, the child was noted to have impairments in the reciprocal social domain that included poor eye contact, lack of socially directed, communicative facial expressions, lack of shared enjoyment, poor social overtures, and lack of responding to joint attention bids. In addition to the social-emotional symptoms noted throughout the developmental evaluations, this child was also noted to have consistent difficulties or abnormalities in motor development and muscle tone, sensory integration and processing (i.e., hypersensitivity to touch and sounds), feeding and sleeping, triadic communication, and language development.

Bryson et al. (2007) also provided informative descriptions and observations of a group of 9 high-risk infant siblings of children with autism who themselves went on to develop an ASD. The infants were followed from 6 months to 24 months of age at 6-month intervals with a final diagnostic assessment occurring at age 3. Results revealed that all nine children, to some degree, showed early impairments in social-communicative development, including lack of interest or pleasure in others. At 6 months of age, all 9 infants were described as having “consistent and sustained eye contact” as well as good social smiling. However, by 12 months of age, 6 of the 9 infants were described as having distinctly observable difficulty with eye contact, social smiling, and/or social anticipation of a familiar dyadic peek-a-boo game routine. Eye contact at 12 months was often qualitatively described as being “fleeting” or “inconsistent.” Several children who showed inconsistent social smiling were described as only sharing their enjoyment with others during physically stimulating games (e.g., tickling) rather than during other structured social games (e.g., peek-a-boo). These findings are consistent with several other studies showing a lack of significant social or affective differences for Sibs-ASD prior to 6 months of age, but noting readily apparent differences by 12 months of age, suggesting that this period in the second half of the first year may be critical for studying the developmental trajectory of early social-emotional skills. By 18 months of age, 8 of the 9 children were described as having few to no initiated social-communicative acts (e.g., showing objects to others to share interest, pointing to request an object out of reach) and it was reported that any observed attempts to communicate usually were poorly coordinated with eye contact.

In addition to these early social-emotional difficulties, these infants also demonstrated a qualitatively atypical temperamental profile characterized by irritability, high levels of distress and negative affect, poor self-regulation, and being difficult to soothe. The developmental course of these temperament behaviors remains unclear as some babies were relatively "easy" and passive initially while others demonstrated signs of difficult temperament even as young as 6 months of age. However, a tendency toward overly negative or neutral affective expressions and reactions could create atypical dyadic social interactions, during which frequent bouts of reciprocal, shared positive affect would be expected, thus perpetuating a negative feedback loop.

Implications for using Positive Affect Sharing in Early Screening Tools for Autism

Many of the behaviors used as risk-markers in current early screening tools for autism (e.g., CHAT, Baron-Cohen et al., 1996; M-CHAT, Robins et al., 2001; STAT, Stone et al., 2000) include triadic joint attention (e.g., protodeclarative pointing, showing objects) and pretend play skills that are only expected to begin to emerge in the latter half of the first year if not later in typical development. Swinkels and colleagues (2006) aptly pointed out that, "A delay in the development of a behavioral skill can only become apparent at an age at which the vast majority of children have mastered the skill. This questions the usefulness of behaviors relating to person- to-person object interactions for the detection of ASD in children younger than 18 months" (p.724).

Several very recent studies have attempted to address the need of the field to develop screening tools for infants under 18 months that examine early behavioral abnormalities that may be precursors for the later-observed classic diagnostic symptoms of autism. Swinkels et al., (2006) developed the Early Screening of Autistic Traits Questionnaire (ESAT), which is designed as a parent checklist for children ages 8-20 months. This study found that 14 critical items related to play, sensory sensitivity, appropriate affect, social interest and responsivity, and repetitive movements showed good sensitivity for ASD. Additionally, this study supported the idea that more advanced social-communicative behaviors (e.g., joint attention) or play (e.g., pretend play) may be less sensitive (i.e., more false positives) to ASD in children under 12 months of age as these skills are still developing and are strongly influenced by age effects during this period.

Bryson and colleagues have developed the Autism Observation Scale for Infants (AOSI, 2008), which is a semi-structured observational assessment examining 18 specific risk markers for autism in early infancy and has been tested with infants as young as 6 months of age. Target behaviors include visual tracking and attention shifting, coordination of gaze with behavior, imitation, affective responsivity (e.g., reciprocal social smile), reactivity, early social-communication behaviors (e.g., eye contact, orient to name, social babbling), and sensory-motor development. Many of these behaviors relate directly to positive affect sharing (e.g., social-communicative behaviors, social smiling), while others may be indirectly related through their potential link to eye contact (e.g., visual attention) or emotional development (e.g., reactivity/temperament).

Zwaigenbaum et al. (2005) used the AOSI and a parent report measure of early temperament characteristics to examine early autism-related behaviors in 65 at-risk infant Sibs-ASD at 6, 12, and 24 months of age. Data for Sibs-ASD were reported and analyzed by group according to their diagnostic classification at 24 months (i.e., Autism, ASD, non-ASD) and were also compared to typical controls. Results revealed that no group differences were found for early behavioral markers on the AOSI at 6 months of age, though it was noted that individual children did show some atypical behaviors at this age. At 12 months, several individual AOSI markers predicted a later autism classification at 24 months, including atypical eye contact, social smiling, social interest, orienting to name, reactivity, imitation, and sensory behaviors, as well as atypical visual tracking and disengagement of visual attention. These authors noted that early impairments in visual attention shifting or disengagement could potentially underlie or relate to the social orienting deficits observed in children with autism. Additionally, Sibs-ASD who met criteria for autism at 24 months showed a distinct developmental pattern of temperament characterized by reduced activity and high passivity at 6 months followed by frequent and intense displays of distress at 12 months. Many of the behavioral findings from this study have clear implications for early social-emotional development, particularly in the child's ability, propensity, or motivation to be socially engaged with others and to share positive affect with a social partner.

Taken together, the studies on early behavioral markers and screening for autism suggest that social and affective behaviors often appear to be impaired in infants who receive a diagnosis of ASD. There are several inconsistencies across studies and there is clearly no universal profile of social-emotional development for young children with autism. However, several studies have reported relatively consistent findings of early impairments in dyadic social orienting (i.e., responding to name), emotional regulation and temperament, eye contact, and positive affect sharing or social smiling. Cassel and colleagues noted that, "A growing literature suggests that reductions in affect expression manifested both as atypical neutrality and reductions in positive emotion are characteristic of the broad ASD phenotype in the first year of life" (2007, p. 129). Most studies seem to show more consistent and clear social and emotional abnormalities in development in the later half of the 1st year or early in the 2nd year of life. However, less is known about the behavioral markers of autism that may be evident in the first 6 months of life as few studies have examined infants at these ages and those that have often report inconsistent or nonsignificant results. It is also important to note that impairments in early social-emotional development do not occur in isolation. Many studies also reported co-occurring developmental differences in cognitive, language, and motor skills.

In summary, positive affect sharing may prove to be an important measure to include in early screening tools for several reasons: (1) it can be readily observed in very early infancy (by parents or experimenters), thus allowing for the downward extension of current tools, (2) it is well-established as an important milestone of social-emotional development in typical children, and (3) it has been theoretically and empirically linked to developmental achievements that are known to be deficient in autism (i.e., joint attention). However, though social attention and positive affect are implicated as early risk markers for autism, their coordination into the unified behavior of shared positive affect has not been thoroughly examined, particularly in prospective studies of young at-risk siblings. Thus, the purpose of the proposed research project is to make a contribution to this important area of study.

CHAPTER II

CURRENT STUDY

The current study examined the social-emotional behavior of shared positive affect in a sample of younger siblings of children with autism (Sibs-ASD) or typical development (Sibs-TD). The aims of the current research were to (1) examine group differences on the construct of positive affect sharing and its behavioral components and (2) to examine how the construct of positive affect sharing relates to outcome measures of autism symptomatology. The purpose of this research was to obtain a more thorough investigation of shared positive affect behaviors in the specified populations and to examine whether this construct may be useful to consider as an early risk marker for autism in future research.

The specific hypotheses for the current study were divided into two sets to address these aims. First, the current study was designed to investigate how positive affect sharing behaviors (i.e., eye contact and smiling) differ across groups and how they correlate with a theoretically related measure of social engagement. Shared positive affect behaviors were observed and coded within a standardized social-interactive context. The component behaviors of positive affect and social attention were examined separately as well as in combination (see Table 1). A detailed description of this coding system is provided below in the Procedures section. The second set of hypotheses was designed to examine the relation of early, shared positive affect to outcome autism symptomatology.

Table 1. Behavioral Coding Categories for Positive Affect and Social Attention

		POSITIVE AFFECT		
		Yes	No	
SOCIAL ATTENTION	Yes	(1) Shared Positive Affect (SPA)	(2) Social Attention/ Eye Contact to Person (SA-EC)	TOTAL SOCIAL ATTENTION (SA) = SPA + SA-EC
	No	(3) Non-social Smiling (NSS)	(4) No social attention or positive affect (No SA-PA)	
		TOTAL POSITIVE AFFECT (PA) = SPA + NSS		

The specific hypotheses for the proposed study are as follows:

Hypothesis 1-1: (a) Following research on the early development of Sibs-ASD, it was expected that a significant group difference on Total Positive Affect (see Table 1 above; SPA [cell 1] + NSS [cell 3]) would emerge, with Sibs-TD showing more overall positive affect than Sibs-ASD (Bryson et al., 2007; Cassel, et al., 2007; Dawson et al., 2000). This result would suggest that Sibs-ASD, as a group, display relatively more flat and/or negative affect compared to Sibs-TD. (b) Specifically, a main effect of group on shared positive affect (SPA-cell 1 in Table 1) was expected, such that Sibs-TD would show significantly more SPA compared to Sibs-ASD. (c) In contrast, no effect of group on non-social positive affect was expected, as rates of non-social smiling (NSS-cell 3 in Table 1) were predicted to be relatively low overall. (d) Given that positive affect is often observed within a social context (Adamson & Bakeman, 1985; Field, 1990; Tronick, 1982), a significant main effect of "positive affect type" (i.e., social/shared SPA vs. non-social NSS) was predicted, with both groups expected to show more SPA than NSS. (e) Finally, a Group X Positive Affect Type interaction was expected such that, Sibs-TD would show a greater difference between social and non-social positive affect (i.e., SPA vs NSS) than Sibs-ASD.

Hypothesis 1-2: Given the literature suggesting that difficulties in social orienting and eye contact are commonly implicated in the early behavioral profiles of children with autism (Dawson et al., 1998; Kasari, Sigman, & Yirmiya, 1993; Volkmar, Cohen, & Paul, 1986), a main effect for Group was expected such that Sibs-TD would display significantly more Total Social Attention (SPA [cell 1] + SA-EC [cell 2]) than Sibs-ASD. Similarly it was expected that Sibs-TD would display significantly more Social Attention-Eye Contact to person (i.e., eye contact without accompanying smile) (SA-EC-cell 2 in Table 1) than Sibs-ASD.

Hypothesis 1-3: The current study was also designed to examine shared positive affect behaviors as a proportion of Total Positive Affect (SPA/Total PA) as well as Total Social Attention (SPA/Total SA). The purpose of these analyses was to gain a better understanding of whether potential vulnerabilities in shared positive affect in Sibs-ASD may be primarily related to general difficulties with affect and emotion or social attention, or whether the differences lie specifically in the coordination of these behaviors. (a) It was expected that the proportion of SPA/Total PA would not differ between groups. That is, after controlling for absolute number of smiles (i.e., general positive affectivity), children in both groups were expected to direct most of their smiles to a social partner while displaying relatively few non-social smiles. Thus SPA/Total PA is expected to be close to 1 for both groups. (b) In contrast, it was expected that Sibs-TD would show a higher proportion of SPA out of Total SA than Sibs-ASD. That is, controlling for general social attention (i.e., total eye contact to person), Sibs-TD were expected to be more likely to smile during episodes of eye contact. In other words, Sibs-ASD were expected to be less likely to show positive affect while looking to a social partner.

Hypothesis 1-4: Children's shared positive affect and social attention were expected to be positively correlated with a concurrent parent report measure of social engagement (i.e., dyadic and triadic behavior). This hypothesis was intended to add construct validity to the measure of shared positive affect as it is theoretically linked to general measures of social engagement (both dyadic and triadic) in development. The strength of the developmental correlations was expected to differ across groups such that the group of Sibs-ASD would show significantly stronger correlations between shared positive affect and parent-reported social engagement than Sibs-TD, as Sibs-ASD were expected to show greater variability on both measures than Sibs-TD.

Hypothesis 2: The next set of study aims were designed to examine the relation of early, shared positive affect to outcome autism symptomatology. (a) Shared positive affect was expected to be significantly and negatively correlated with later continuous measures of autism symptomatology. (b) In addition, it was expected that the Sibs-ASD group would show a significantly stronger correlation between shared positive affect and autism symptomatology than the Sibs-TD group, as Sibs-ASD were expected to show greater variability on both measures than Sibs-TD.

CHAPTER III

METHOD

Participants

Participants in the study were drawn from a larger sample of families who were recruited to participate in a longitudinal research study examining the early development of younger siblings of children with autism being conducted at the Treatment and Research Institute for Autism Spectrum Disorders (TRIAD) at Vanderbilt University in Nashville, Tennessee.

Recruitment for the larger sibling study occurred from 2003 through 2006. Two primary groups were targeted for recruitment: (1) younger siblings of children with autism spectrum disorders (Sibs-ASD) and (2) a control group of younger siblings of children with typical development (Sibs-TD). The majority of Sibs-ASD (61%) were recruited through a university-based autism-specialized service and outreach program via newsletters, flyers, and websites; other recruitment sources included regional multidisciplinary evaluation and speech-language centers (21%) and professionals or other community resources (18%). The majority of Sibs-TD were recruited through a birth-record database in the metropolitan area (42%), with others recruited through a university email announcement (32%) and word-of-mouth (26%).

Initial phone screen interviews determined eligibility for participation in the study. Eligibility requirements for both groups were: (1) Chronological age (CA) between 12 and 23 months at the initial visit; (2) Absence of severe sensory or motor impairments that would impede completion of research assessments; (3) Absence of identified metabolic, genetic, or progressive neurological disorders; (4) English as the primary language spoken at home; and (5) An older sibling. Eligibility for the Sibs-ASD group required having an older sibling with autism, PDD-NOS, or Asperger's disorder (subsequently referred to as "proband"- defined as the clinically affected member of a family). Eligibility for the Sibs-TD group required that the older sibling have no developmental disorders and that there be no family history of autism or mental retardation in first degree relatives.

As of September 1, 2007, 66 Sibs-ASD and 38 Sibs-TD were enrolled in the study. Follow-up assessments continued through the spring of 2008. From the larger sample, videotapes of 77 children (Sibs-ASD, n=49; Sibs-TD, n = 28,) were selected for coding and analysis for the present study. Participants selected for this study included children who had or were expected to have all data at both the initial and outcome assessments as well as Sibs-ASD for whom proband diagnoses were confirmed through direct clinical observation and assessment with standardized diagnostic tools (i.e., ADOS and/or ADI-R; Lord et al, 1989, 2000; Lord et al., 1994). Sibs-ASD were over selected as they are the primary group of interest and to increase the likelihood that there would be enough power to detect potential subgroups (e.g., diagnostic categories) within the sample.

Of the 77 videotapes originally selected for coding, five tapes were eliminated. These tapes included two Sibs-ASD participants (1 male, 1 female) and three Sibs-TD participants (2 males, 1 female). These five tapes were eliminated because the videos could not be coded reliably due to reasons including having more than 25% of the tape having obstructed or unobservable views, having missing, incorrect, or incomplete data or information on the tape or coded file, and technical difficulties with the video tape and/or coding software. In addition, preliminary analyses identified one multivariate outlier (female, Sibs-ASD, age 20 months) that was removed from further analyses (see additional information in the Preliminary Analyses section of the Results below). The final sample used for analyses included 71 participants (46 Sibs-ASD and 25 Sibs-TD). Four participants, all from the Sibs-ASD group, did not have available follow-up data at Time 2. Analyses using follow-up Time 2 data included 42 Sibs-ASD and 25 Sibs-TD (94% of Time 1 sample). In addition, one Sibs-ASD participant did not have valid scores from the follow-up cognitive assessment, so the Time 2 Mental Age descriptive information is based on 41 Sibs-ASD participants.

At Time 1, children ranged in chronological age (CA) from 12-23 months (Mean CA: 15.27 months). Mental age (MA) was based on age equivalent scores from the Mullen Scales of Early Learning (i.e., average of four subscale age equivalents from MSEL). Mental age scores at Time 1 ranged from 10.5-27.25 months (Mean MA: 15.84 months). The sample included 42 male participants (59%) and 29 female participants (41%). Participants were primarily white/Caucasian (62, 87%); two participants (3%) were black/African American, two participants (3%) were Hispanic/Latino, and 5 participants were multi-racial (7%). Mothers' education levels ranged from high school graduate or GED to Graduate or Professional Degree; the majority of mothers had a college degree or above (58, 82%).

At Time 2, children ranged in chronological age (CA) from 29-44 months (Mean CA: 33.96 months). Mental age (MA) scores ranged from 12.5-55.25 months (Mean

MA: 35.07 months). At Time 2, the sample included 39 male participants (58%) and 28 female participants (42%). Racial demographics included white/Caucasian (60, 90%), black/African American (1, 1.5%), Hispanic/Latino (1, 1.5%), and multi-racial (5, 7%). Mothers' education levels remained relatively high with 82% of mothers having a college degree or above (55, 82%).

Participant characteristics and demographics are reported by group in Table 2 below. T-tests were used to compare Sibs-ASD and Sibs-TD on chronological age (CA) and mental age (MA) at both time points. Sibs-ASD did not differ from Sibs-TD on Time 1 CA, $t(69)= -.341$, $p = .73$, Time 2 CA, $t(65)= -.216$, $p = .83$, Time 1 MA, $t(69)= -1.58$, $p = .12$, or Time 2 MA, $t(64)= -1.59$, $p = .12$. Chi-square statistics were used to compare groups on gender, race (4 categories represented: White/Caucasian, Black/African American, Hispanic/Latino, & Multi-racial, resulting in 3 degrees of freedom), and maternal education demographics (4 levels represented: High School Degree or GED, Partial College, College Degree, and Graduate Degree, resulting in 3 degrees of freedom). Race and maternal education subgroups were collapsed into major groupings for simplifying descriptive purposes in Table 2.

Chi-square tests revealed no differences between groups for gender at Time 1, χ^2 (1) =. 375, $p = .54$, or Time 2, χ^2 (1) =. 550, $p = .46$. No differences were found between groups on race at Time 1, χ^2 (3) = 3.52, $p = .32$, or Time 2, χ^2 (3) = 2.30, $p = .51$. Chi-square tests revealed a significant difference between the groups for maternal education at Time 1, χ^2 (3) = 10.49, $p = .015$, and Time 2, χ^2 (3) = 9.00, $p = .029$; the mothers of Sibs-TD had a significantly higher education level on average than the mothers of Sibs-ASD (i.e., Sibs-TD group had 92% of mothers completing at least a college degree, including 52% of mothers that had completed a graduate degree, compared to 76% of Sibs-ASD mothers with at least a college degree and 17-19% with a graduate degree).

Table 2. Participant Characteristics and Demographics

Follow-up Time 2 information is based on 42 Sibs-ASD participants; Time 2 mental age information is based on 41 Sibs-ASD participants.

	Sibs-ASD (*n*=46)*		Sibs-TD (*n*=25)
Chronological Age Time 1			
Mean (SD)	15.17 (3.02)		15.44 (3.34)
Range	12-23		12-23
Chronological Age Time 2*			
Mean (SD)	33.88 (3.34)		34.08 (4.12)
Range	30-42		29-44
Mental Age Time 1			
Mean (SD)	15.35 (3.30)		16.74 (3.94)
Range	10.5-25.75		11.5-27.25
Mental Age Time 2*			
Mean (SD)	33.96 (7.44)		36.90 (7.07)
Range	12.5-48.25		28.25-55.25
Gender	Time 1	Time 2*	
Male (%)	20 (43.5%)	23 (55%)	16 (64%)
Female (%)	26 (56.5%)	19 (45%)	9 (36%)
Race	Time 1	Time 2*	
Caucasian (%)	40 (87%)	38 (91%)	22 (88%)
African American (%)	2 (4%)	1 (2%)	0 (0%)
Other (%)	4 (9%)	3 (7%)	3 (12%)
Maternal Education	Time 1	Time 2*	
Completed High School (%)	46 (100%)	42 (100%)	25 (100%)
College Degree or above (%)	35 (76%)	32 (76%)	23 (92%)

Procedure

The research protocol received approval from the Vanderbilt University Institutional Review Board. Informed consent was obtained from parents for all participants, including consent to videotape the sessions for research purposes. All assessments and interviews were conducted or supervised by experienced licensed psychologists, in collaboration with reliably trained graduate students or research assistants. Each measure was administered by a different member of the research team in a single 3-hour session (with the exception of the Childhood Autism Rating Scale; CARS – see measures section below). All data were collected during the course of the child's visit or through paperwork completed by parents at home and brought with them on the day of the evaluation. In rare cases, families were re-scheduled for a second session due to child fatigue. Examiners were not blind to sibling group.

For the larger longitudinal sibling study, families participated in a total of five clinic visits across an 18-month period. Only data from two time points, the first initial evaluation and the outcome evaluation, will be used for the current study. The final and fifth visits were conducted approximately 18 months from the initial evaluation. If any children in the sample selected for this study were missing data from their fifth and final evaluation, then data from the fourth visit (~1 year after initial evaluation) was used when available.

At the initial evaluation, all children received the STAT and the Mullen Scales of Early Learning (MSEL; Mullen, 1995). Parents also completed a demographic information form and a questionnaire regarding their child's social engagement (see Measures section below). At the follow-up evaluation, children received the outcome diagnostic assessment. Results from the MSEL were available for 93% (66/71) of participants at follow-up because all data from 5 Sibs-ASD participants was missing at follow-up. Additional data from experimental measures and assessments were available as part of the larger sibling study, but were not considered or described for the purposes of the current study. Based on the results of the outcome diagnostic assessment, participants were classified into six mutually exclusive outcome diagnostic categories as follows: autism, pervasive developmental disorder not otherwise specified (PDD-NOS), developmental delay (DD), language impairment (LI), broader autism phenotype (BAP), and no concerns. For the purposes of this study, the DD and LI categories were examined descriptively and were not included as separate subgroups in any further analyses. Licensed psychologists with experience in the diagnosis of young children with autism made the diagnostic decisions. Diagnosis of an autism spectrum disorder was based on the ADOS (Lord et al., 2000) and clinical diagnostic criteria provided in the *Diagnostic and Statistical Manual of Mental Disorders–Text Revision* (DSM-IV-TR: American Psychiatric Association, 2000). The BAP category was used for children who did not qualify for any of the aforementioned diagnostic categories, but for whom there were clinical concerns related to social-communicative functioning; both clinical concerns and a score exceeding the cutoff for ASD on the ADOS social domain were required. Children not meeting criteria for any of the other categories were classified into the no concerns category (i.e., considered to be typically developing).

Primary coders of the STAT attention and affect variables were blind to the group and outcome status of the participants during coding. One undergraduate student in psychology (H.B.) coded the majority of the tapes used for analyses (65/71, 92%). Three other students (i.e., two psychology undergraduates and one graduate student in child studies) coded a total of 6 tapes (8%) that were used in the present study. All coders were reliably trained using practice videotapes that were not used for data purposes in the present study. Twenty-six tapes were randomly selected for coding reliability. The secondary coder (author C.M.), while only using ID numbers during reliability coding, was familiar with some of the participants due to involvement with the study and was not fully blind to group and diagnosis of the participants. Twenty-five of the tapes coded for reliability (outlier removed; 35% of total sample) were used for interrater reliability analyses. After both raters coded these tapes, the tapes were then re-examined by the author to resolve disagreements before entering the final values of the coded variables into the dataset for analyses.

Measures

Time 1 Initial Evaluation Measures

Family Information Form-Demographics

At their initial evaluation, parents completed an information form that included questions about family history and parental occupation and educational history. Additional information (e.g., related to contact information and whether the child was receiving any intervention services) was obtained for children at all time periods. Information about parental occupation and education were updated at the final 5^{th} evaluation. Maternal education was used as a measure of socioeconomic status in the present study; it was used to describe and match samples, and was entered as a covariate in analyses when necessary.

Observation Context-Screening Tool for Autism in Two-Year-Olds

All sessions were videotaped. For the current proposed study, the *Screening Tool for Autism in Two-Year-Olds* (STAT; Stone et al., 2000; Stone & Ousley, 1997) at Time 1 served as the context during which positive affect sharing behaviors were coded from videotape. The STAT is an observational, interactive screening tool developed to identify autism risk in children between 24 and 36 months old. Items on the STAT were derived empirically on the basis of their ability to differentiate between children with autism and developmentally-matched controls. It consists of 12 activity-based items that are coded live and assess four social-communicative domains: Play (2 items), Requesting (2 items), Directing Attention (4 items), and Motor Imitation (4 items). It is conducted within a game-like format and is usually completed in less than 20 minutes. The child and examiner sit near each other on the floor or at a table for the various tasks.

Within each domain, items are scored as pass or fail according to specific behavioral criteria, and domain scores reflect the number of items passed. The Total STAT score is calculated from the average number of failures across domains; this score ranges from 0 to 4 (in increments of .25). Higher Total scores represent more impaired social-communicative performance, with scores of 2 or above indicating autism risk. The STAT has strong screening properties for 24-36 month olds, including sensitivity and specificity, interobserver agreement, test-retest reliability, and concurrent validity with the ADOS and clinical diagnosis (Stone et al., 2004). The Total STAT score provides a measure of social-communicative functioning and correlates with ADOS-G classification (Stone et al., 2004). Though originally designed as a screening measure for 2-year-olds, the STAT has also been used as a context for eliciting and observing social and communication skills (e.g., McDuffie, Yoder, & Stone, 2005). Its use as a screening tool has also been extended to children as young as 12 months of age (Stone, McMahon, & Henderson, 2008). In the larger sibling study, reliably trained graduate students or research assistants administered the STAT to all children at each of the five visits.

Observed Behaviors and Coding System

Videotapes were coded for shared positive affect behaviors. Procoder (Tapp & Walden, 1993), a coding system for behavioral research using videotape, was used to code the STAT for each participant. A continuous coding procedure was used to mark five mutually exclusive categories as follows: (1) Shared Positive Affect (SPA; eye contact to person coordinated with smile), (2) Social Attention-Eye Contact (SA-EC; eye contact to person without smile), (3) Non-Social Smiling (NSS; smiling that is not coordinated with eye contact to person), (4) no smile or eye contact to person observed (No SA-PA), and (5) unobservable (e.g., due to child's face off camera).

For coding these variables, the entire STAT was viewed at ¾ speed to ensure accuracy of timing of observations. An "on/off" coding system was used such that the start of a coded behavior was marked and timed for as long as the coded behavior remained observable. Thus, the timing of the initial code continued until a different code-able event occurred, so that the end time of the initial code will be essentially equivalent to the start time of the subsequent code. These coding procedures allowed for both duration and frequency of the behaviors to be obtained and ensured that there were no measurable moments without a code.

Only positive affect was considered in the current study because of its theoretical relationship to social interaction and joint attention. Additionally, previous research has shown negative affect to occur relatively infrequently, making it a variable that is often excluded from data analyses post-hoc (Mundy, Kasari, & Sigman, 1992; Snow et al., 1987). Shared positive affect (SPA) was coded when the child was observed to laugh or smile within a tenth of a second (either before or after) a look to the examiner's face (i.e., eye contact to person). Thus, when a shared positive affect event occurred, the SPA code will take precedence over the SA-EC code, which is described in detail below. At least 1/3 of the child's mouth had to be observable on camera in order to qualify as a code-able smile. Furthermore, SPA was only coded if: (1) it appeared to the coder that the expression accompanied positive feelings in the child (e.g., to distinguish chewing or talking that resembles smile in freeze frame from true smile), (2) the "smile" was held for a measurable/code-able amount of time (i.e., greater than or equal to 0.1 seconds), and (3) the "smile" could be distinguished from the child's overall expressions surrounding the act in question. If clear eye contact had been established, but positive affect information was ambiguous or unobservable, only the social attention-eye contact code was retained.

The social attention-eye contact (SA-EC) variable was coded when the child turned his or her head and/or directed his or her face and/or eye gaze to the experimenter's face such that at least some part of the experimenter's face was in the child's direct line of vision. Direct line of vision was defined as the space projected from the perimeter of the child's face, including forehead and chin (imaginary megaphone or cone of focal vision extending from the child's face and including at least some part of the experimenter's face in its scope). This definition enabled this behavior to be coded when the child's face was only partially observable on camera (e.g., head turn and direction observable but eye gaze direction not observable). However, when observable, eye gaze always took precedence over the direction of the child's head for coding purposes (e.g., looks to the side or corner of the eye were included when observable). To avoid difficulty obtaining reliability on coding fleeting or otherwise difficult-to-observe eye contact, the following rules applied: (1) the look to the examiner's face must last for at least a duration of 0.1 seconds, (2) both the examiner and the child's face must be at least partially observable on camera, and (3) if the coder was still uncertain after viewing the event 3 times, eye contact would not be coded. Additionally, as noted above, if a smile was observed to occur within 0.1 seconds of the social look, SPA was coded as it was designed for the purposes of this study to take precedence over SA-EC.

The non-social smiling (NSS) code was defined as the SPA code above, except that it occurred without coordinated eye contact to the examiner. That is, NSS was coded if (1) it appeared to the coder that the expression accompanied positive feelings in the child, (2) the "smile" was held for a count of at least 0.1 seconds, (3) the "smile" could be distinguished from the child's overall expressions surrounding the act in question, *and* (4) the "smile" did not occur with coordinated eye gaze to a social partner. The attentional focus (e.g., to toys, reflection in mirror) of the child's observed non-social smile was not considered in this coding system as the focus of this study was on the presence or absence of socially-directed positive affect.

The code for no eye-contact or smile (No SA-PA) was marked when the child was *observed* to be displaying non-positive affect (e.g., neutral, negative) *and* to be focusing their visual attention somewhere other than the examiner's face (i.e., child is visible on camera and no codeable smiling behavior as defined above is present). Again, the attentional focus of the child during this time was not coded, as it was not a variable of interest in the current study. Thus, this coding system did not distinguish between a child who was engaged with a toy or other object vs. a child who was unengaged (i.e., no specific observed attentional focus).

The unobservable code was marked when none of the defined behaviors above could be coded due to difficulties with the videotape quality or content (e.g., child's face off camera, examiner's face off camera, poor focus or lighting, etc.). Any videotapes on which the child's face was not easily observable for long durations, or that were generally poor quality overall were excluded from coding and further analyses (i.e., any tape that had 25% or more of the total time marked with the unobservable code was excluded from the sample and all included tapes had to have at least part of every STAT item observable).

At times, a parent/caregiver or other observer was present in the testing room with the child during the STAT administration. Behaviors that were directed to a parent or person other than the primary examiner were not considered in the analyses for present study, as this variable was not standardized across children. Additionally, as the duration of time for the STAT was not standardized across all participants, the duration and frequency of coded variables were considered as rates or proportions over time. Only these rate variables were used for statistical analyses.

The following 5 primary dependent variables were coded from the videotapes: Total Social Attention (i.e., total looks to the examiner's face with or without smiling; SPA + SA-EC), Total Positive Affect (i.e., total smiles with or without looks to the examiner's face; SPA + NSS), Social Attention-Eye Contact (SA-EC; looks to the examiner's face without smiling), Shared Positive Affect (SPA; looks to the examiner's face with smiling), and Non-Social Smiling (NSS; smiling without looking at the examiner).

For each of these codes, frequency and duration were calculated and are reported as proportions of the total time coded (i.e., resulting in rate and time proportion variables). For example, the frequency of SPA occurrences is reported as a rate per second (i.e., total frequency of occurrences divided by total time coded in seconds) and the duration of SPA is reported as a proportion out of the total time coded in seconds. For each of these code categories, the average duration of each occurrence was also recorded. Finally, proportion variables were calculated for the SPA rate and duration variables as follows: Rate SPA/Rate Total SA, Rate SPA/Rate Total PA, Duration SPA/Duration Total SA, Duration SPA/Duration Total PA. These codes are outlined and defined in Table 3 below to serve as a reference guide.

Table 3. Coded Variables Reference Guide

Code	**Definition/ Description**
Total Social Attention (Total SA)	SPA + SA-EC
Total Positive Affect (Total PA)	SPA + NSS
Shared Positive Affect (SPA)	Social attention-eye contact to examiner with a smile
Social Attention-Eye Contact (SA-EC)	Social attention-eye contact to examiner without a smile
Non-Social Smiling (NSS)	Smiling not accompanied by eye contact to examiner
Measured Variables	
Rate	Total frequency of coded behavior (i.e., absolute number of occurrences) divided by total time (reported as rate per second)
Time	Total time of coded behavior (i.e., sum of duration of each occurrence) divided by total time in seconds
Average Duration	Mean duration of each occurrence of coded behavior in seconds (i.e., sum of durations of occurrences divided by total occurrences). Duration of each occurrence was calculated by subtracting the start time of the coded behavior from the end time of the coded behavior.
Proportion Variables	
Rate SPA/ Total SA	Rate of shared positive affect divided by rate of total social attention
Rate SPA/ Total PA	Rate of shared positive affect divided by rate of total positive affect
Time SPA/ Total SA	Time of shared positive affect divided by total time of social attention
Time SPA/ Total PA	Time of shared positive affect divided by total time of positive affect

Parent-Reported Social Engagement

The *Detection of Autism by Infant Sociability Interview* (*DAISI*; Wimpory et al., 2000) is a semi-structured parental interview developed to measure social engagement behaviors present before 2 years of age. Items assess early dyadic interactions (e.g., waving, preverbal turn-taking) as well as triadic interactions (e.g., referential eye contact, following others' points). When used retrospectively with parents of 2-4 year olds who had not yet been diagnosed, 15 of the 19 items (and the total score) differentiated the subgroup with autism from the subgroup with developmental delay (Wimpory et al., 2000). The DAISI items are outlined in the Appendix.

In the present study, the 15-item version was used; total scores range from 0-15, with higher scores reflecting more optimal social-communicative development. Additionally, from the 15 critical items, separate subscales for dyadic (10 items) and triadic (5 items) interaction behaviors were calculated according to the following categories indicated by Wimpory et al. (2000). (A) Person-to-person (i.e., dyadic) communicative expressions included: the frequency and intensity of eye contact (Item 1); greeting the parents (Item 3); enjoying lap games (Item 7); sociability in play with or without toys (Items 9 and 6); waving (Item 14); raising the arms to be picked up (Item 15); socially directed feelings of anger and distress (Item 18); and preverbal turn-taking and using noises communicatively (Items 17 and 19). (B) Person-person-object ("triadic") interactions included: the referential use of eye contact (Item 2); offering and giving objects to others (Item 10); showing objects to others (Item 11); pointing at objects and following others' points (Items 12 and 13) (see Appendix).

The DAISI was administered to the parents of all children at the initial visit. It was used as a concurrent measure of dyadic and triadic functioning for comparison to the coded shared positive affect variables.

Time 2 Outcome Autism Symptomatology Measures

Childhood Autism Rating Scale (*CARS*; Schopler, Reichler, & Renner, 1986).

The CARS is a 15-item observational scale that was used to assess autism symptomatology. CARS items assess behaviors such as relating to people, resistance to change, communication, and body use. Each behavior is rated on a 4-point scale (including midpoints) according to its degree of abnormality. Total scores range from 15-60, with scores above 30 suggesting the presence of autism. Test-retest for the total score is .88 and correlations with clinical ratings of autism are .84 (Schopler et al., 1986). The CARS has been found to be superior to other diagnostic instruments for autism in its discriminant validity (Teal & Wiebe, 1986) and other psychometric properties (Morgan, 1988). This measure was completed collaboratively by the research team for both groups at Time 1 and Time 2 after observing the child's behaviors during the entire session. The total CARS score was used in the present project as a continuous measure of autism symptom severity, as consistent with previous research (Coplan & Jawad, 2005; Perry et al., 2005).

Autism Diagnostic Observation Scale (*ADOS*; Lord et al., 2000).

The ADOS is a semi-structured observational assessment of play, social interaction, and communicative skills that was designed as a diagnostic tool for identifying the presence of autism. It is organized into four modules, which are distinguished by their appropriateness for use with individuals functioning at different developmental levels, ranging from nonverbal children to highly fluent adults. Each module provides a set of behavioral ratings and an algorithm that can be used for the diagnosis of autism and PDD-NOS. Across all modules, interobserver agreement for the algorithm score was .92, and the test-retest correlation was .82 (Lord et al., 2000).

Agreement about diagnostic classification (autism vs. PDD-NOS vs. nonspectrum) ranged from 81%-93% (Lord et al., 2000). Module 1 or 2 of this measure was administered to children in the Sibs-ASD sample at follow-up (16 participants (38%) received Module 1 and 26 participants (62%) received Module 2). In the present study, the ADOS was used to determine end-point diagnosis for descriptive purposes and the Total Score on the algorithm was used as a continuous measure of autism symptom severity (Lord, Leventhal, & Cook, 2001). Additional ADOS subscale scores were also run through the correlational analyses; these included the Social Communication Score and Reciprocal Social Score from the original ADOS scoring algorithms as well as the revised algorithm scales of Social Affect, Restricted Repetitive Behaviors, and the sum of these latter two scales (Gotham et al., 2007).

Autism Diagnostic Interview – Revised (*ADI-R*; Lord et al., 1994).

The ADI-R is a semi-structured, investigator-based interview for parents/caregivers that was developed for the purpose of diagnostic classification. The ADI-R provides explicit scoring criteria and a DSM-IV-based diagnostic algorithm that yields cutoff scores in the domains of social reciprocity, language and communication, and restricted and repetitive activities. This measure possesses strong psychometric properties in terms of inter-observer agreement, internal consistency, and test-retest reliability. The ADI-R has been found to discriminate autism from non-autism in individuals with mental ages of at least 18 months (Lord et al., 1997). The short form of the ADI-R was used in the present study for the Sibs-ASD to confirm end-point diagnosis for descriptive purposes.

Data Analyses

Preliminary Analyses

Data analyses were conducted in several stages. First, descriptive statistics (i.e., central tendency, variability, skewness, kurtosis) were examined for all study variable distributions. One multivariate outlier was identified and removed. Appropriate transformations or nonparametric statistics were used to correct for assumption violations (e.g., non-normal distribution) when necessary. Next, Pearson correlations among demographic variables (e.g., maternal education) and study variables were examined. Demographic factors that were significantly associated with the study variables were controlled in subsequent analyses as appropriate.

Analysis of Variance

To test for the main effects of group and positive affect type, as well as their interaction, a Mixed Model ANOVA (using the repeated measures linear model) was conducted with Group (two levels: Sibs-ASD and Sibs-TD) as the between-subjects variable and positive affect type (two types: Social/Shared [SPA] and Non-social [NSS]) as the within-subjects variable. Planned contrasts were used to test the hypothesis that Sibs-TD would show significantly more Total PA and SPA compared to Sibs-ASD, and that no difference on NSS would emerge. Planned contrasts were also used to test the hypothesis that, on average, participants would show significantly more SPA than NSS. Finally, planned contrasts were used to test the hypothesis that Sibs-TD would show a greater difference between SPA and NSS than Sibs-ASD. Transformed (i.e., square root transformation to create normal distribution) rate and time variables were each run through the analyses with gender and maternal education entered as covariates (see further details in Preliminary Analyses section in the Results below). The average duration of SPA and NSS were also run through the Mixed Model ANOVA analyses (no transformation necessary, maternal education entered as a covariate).

A univariate ANOVA was used to test the prediction that Sibs-TD would display significantly more social attention than Sibs-ASD. These analyses were run for the Total SA as well as the SA-EC variable. The rate, time, and average duration of social attention variables were each compared across groups (no transformation or covariates were necessary).

Shared positive affect proportion variables were computed for each individual participant: (a) SPA/Total PA and (b) SPA/Total SA. Proportions for both rate and time variables were computed. Univariate ANOVAs were run separately to compare the groups on each of the proportions in order to test the predictions that (a) SPA/Total PA would not differ between groups, with children in both groups expected to direct most of their smiles to a social partner while displaying relatively few non-social smiles and (b) that Sibs-TD would show higher SPA/Total SA than Sibs-ASD (i.e., Sibs-ASD would be less likely to show positive affect while looking to a social partner). Transformed variables were used to compare groups on the rate and time of SPA/Total SA (with maternal education entered as a covariate), and time of SPA/Total PA.

All ANOVA analyses used to test for group effects on the coded dependent variables were run in three series: (1) First, including the entire sample, (2) second, removing participants who received a diagnosis of an autism spectrum disorder (ASD) at their outcome evaluation from the analyses, and (3) third, removing participants who received an ASD diagnosis or were classified as meeting criteria for the broad autism phenotype (BAP) category from the analyses.   This series of analyses was performed because it was anticipated that the number of children who would receive an outcome diagnosis of ASD would be relatively low. Therefore, it was expected that there would not be enough power to statistically predict the categorical variable of outcome diagnostic group. If group differences remain after removing the children with ASD from the Sibs-ASD sample, it would suggest that younger siblings of children with autism might have sub-clinical developmental vulnerabilities that may be indicative of the broader autism phenotype. On the other hand, if group differences were no longer found after removing the children with ASD from the analyses, it would suggest that these few children exerted undue influence on the results and are not representative of the group of Sibs-ASD as a whole. Additionally, descriptive information was provided about the demographics and social-emotional behaviors of the children who received an ASD diagnosis at follow-up.

Correlational Analyses

Pearson bivariate correlations were run between the coded behaviors and the parent report measure of social engagement to test the hypothesis that SPA and social attention would be positively correlated with the social engagement measure. Correlations were then re-run within groups to obtain the correlation coefficients between SPA and social attention and the social engagement measure for each group. For significant correlations, Fisher's z test was used to compare the relative strength of the correlation between groups to test the hypothesis that Sibs-ASD will show significantly stronger correlations between shared positive affect and parent-reported social engagement than Sibs-TD. F-tests were also used to compare the variances between the groups on both the shared positive affect behaviors and the parent report measure to test the hypothesis that Sibs-ASD are expected to show greater variability on both measures than Sibs-TD. Partial correlation analyses were used to control for the covariates of maternal education, gender, chronological age, and/or maternal education as appropriate.

Pearson bivariate correlations were used to test the relation between the coded behaviors and the continuous outcome measures of ASD symptomatology (CARS and/or ADOS [Sibs-ASD only]) and the hypothesis that SPA would be significantly and negatively correlated with later measures of autism symptomatology. Separate within-group Pearson bivariate correlations between coded variables and the CARS were then run for each group. Fisher's z-tests were used to compare the relative strength of correlations between the groups and test the hypothesis that Sibs-ASD would show a significantly stronger correlation between shared positive affect and autism symptomatology than the Sibs-TD group. F-tests were also used to compare the variances between the groups on both SPA and the CARS to test the hypothesis that Sibs-ASD would show greater variability on both measures than Sibs-TD. The ADOS measure of autism symptomatology was not used to test this latter hypothesis as none of the participants in the Sibs-TD group received this assessment at their final evaluation. Transformed variables and partial correlations to control for the covariate of maternal education were used in analyses as appropriate.

Sample Size and Power Analyses

Power analyses were conducted to determine the sample size required to address the primary research aims of this study. Power analyses revealed that a sample size of at least 21 participants per group for a one-tailed test and 26 participants per group for a two-tailed test provides a power of .80 ($p < .05$) to detect a large effect of .80 or larger (Note: by convention .80 is generally considered an acceptable level of power). A sample size of at least 51 participants per group (one-tailed) or 64 participants per group (two-tailed) would provide a power of .80 ($p < .05$) to detect a medium effect of .50. This suggests that the current study's sample size of 71 (46 Sibs-ASD, 25 Sibs-TD) may only have the power to detect relatively large effects of .80 or larger. Therefore, any group differences that emerge that have small to medium effect sizes (i.e., smaller than .80) should be interpreted with caution and replicated in future research studies.

Post-hoc Analyses

Following preliminary analyses revealing a significant correlation between gender and several of the coded dependent variables, post-hoc Univariate ANOVA analyses were conducted to compare all the study's dependent variables of interest across genders. Additionally, exploratory correlational analyses between the coded dependent variables of interest and the STAT Total score at Time 1 and Time 2 were conducted post-hoc. The STAT Total Score was selected as it provides a measure of social-communicative performance and has been shown to have good screening properties within this sample of younger siblings (Stone, McMahon, & Henderson, 2008), thus allowing another way to assess the validity of the coded shared positive affect variables.

CHAPTER IV

RESULTS

Preliminary Analyses and Descriptive Data

First, interrater reliability was calculated for each of the dependent variables. Interrater reliability was generally strong; intraclass correlation coefficients for rate and time proportion variables ranged from .819 to .968. Interrater agreement on the average duration of occurrences ranged from .555 to .903. There appeared to be greater difficulty establishing strong agreement on the duration of occurrences involving smiling (coefficients range from .555-.718) versus the duration of occurrences involving looks (coefficients range from .718-.902). From discussions between the coders and review of the tapes, this appeared to be due to difficulty accurately identifying the start and end time of the observed smiles. Coders were still relatively reliable on identifying the presence or absence of the occurrence of smiles. The reliability coefficients for each of the coded dependent variables are reported below in Table 4 (the lowest and highest coefficients are highlighted in bold).

Table 4. Interrater Reliability on Coded Dependent Variables

Dependent Variable	Intraclass Correlation Coefficient (single measure)
Total SA	
Rate	.936
Time	**.968**
Average Duration	.899
Total PA	
Rate	.874
Time	.905
Average Duration	.644
SA-EC	
Rate	.939
Time	**.968**
Average Duration	.903
SPA	
Rate	.936
Time	.965
Average Duration	.718
NSS	
Rate	.819
Time	.874
Average Duration	**.555**

Preliminary analyses indicated a multivariate outlier for a 20-month-old female child in the Sibs-ASD group who had no clinical concerns at the initial or follow-up visits and an Early Learning Composite standard score on the MSEL of 126 at the follow-up evaluation. This participant's score was greater than 4 standard deviations above the mean for the total sample on the rate and time variables of Total PA, SPA, and NSS. Therefore, this outlier was removed from analyses. No other univariate or multivariate outliers were identified.

Descriptive statistics were run for each of the dependent variables to assess for violations of assumptions (e.g., non-normal distribution). Measures of skewness and kurtosis for each of the coded variables are presented in Table 5 and distribution descriptive statistics for the calculated proportion variables are presented in Table 6. It is generally suggested that skew and kurtosis fall between -2 and +2 for the variable to be considered normally distributed.

The variables that violate the assumption of normality are highlighted in bold in the tables below. All of the Total SA, Total PA, SA-EC, and all average duration variables met the assumption of a normal distribution. The only coded variables that violated the assumption of normality were the rate and time of SPA and the time of NSS (Sibs-ASD only). These variables tended to be leptokurtotic (positive kurtosis), suggesting that the majority of participants clustered within a restricted range. The distribution of these variables was corrected using a square root transformation and the resulting normally distributed transformed variables were used in further analyses. The majority of proportion variables (3 out of 4 with the exception of SPA/Total PA) were not normally distributed. The non-normal proportion variables were corrected by using the square root transformation and the resulting normally distributed transformed variables were used in further analyses.

Table 5. Skewness and Kurtosis Descriptives for Coded Dependent Variables

Variable	Group: Total Sample (*n*=71) Mean (S.E.)		Sibs-ASD (*n*=46) Mean (S.E.)		Sibs-TD (*n*=25) Mean (S.E.)	
Total SA	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis
Rate	.566 (.285)	-.012 (.563)	.873 (.350)	.762 (.688)	.143 (.464)	-.647 (.902)
Time	.734 (.285)	.100 (.563)	1.15 (.350)	1.18 (.688)	.119 (.464)	-.595 (.902)
Average Duration	.699 (.285)	.365(.563)	.745 (.350)	.332 (.688)	.773 (.464)	.527 (.902)
Total PA						
Rate	.771 (.285)	-.113 (.563)	.829 (.350)	.095 (.688)	.668 (.464)	-.435 (.902)
Time	.954 (.285)	.266 (.563)	1.16 (.350)	1.10 (.688)	.673 (.464)	-.816 (.902)
Average Duration	-.131 (.285)	.957 (.563)	-.237 (.350)	.559 (.688)	-.366 (.464)	1.79 (.902)
SA-EC						
Rate	.520 (.285)	-.471 (.563)	.715 (.350)	-.191 (.688)	.290 (.464)	-.543 (.902)
Time	.858 (.285)	.559 (.563)	1.23 (.350)	1.78 (.688)	.291 (.464)	-.791 (.902)
Average Duration	.627 (.285)	.085 (.563)	.741 (.350)	.230 (.688)	.387 (.464)	-.269 (.902)
SPA						
Rate	1.47 (.285)	**2.34 (.563)**	1.75 (.350)	**4.77 (.688)**	1.07 (.464)	.579 (.902)
Time	1.74 (.285)	**4.21 (.563)**	1.53 (.350)	**3.53 (.688)**	1.47 (.464)	**2.68 (.902)**
Average Duration	-.330 (.285)	-.378 (.563)	-.348 (.350)	-1.07 (.688)	.003 (.464)	1.21 (.902)
NSS						
Rate	.534 (.285)	-.836 (.563)	.658 (.350)	-.693 (.688)	.406 (.464)	-.942 (.902)
Time	1.20 (.285)	1.28 (.563)	1.42 (.350)	**2.10 (.688)**	.748 (.464)	-.603 (.902)
Average Duration	-.029 (.285)	.436 (.563)	-.125 (.350)	.112 (.688)	-.178 (.464)	.811 (.902)

Table 6. Skewness and Kurtosis Descriptives of Calculated Proportion Variables

Variable	Group: Total Sample (*n*=71) Mean (S.E.)		Sibs-ASD (*n*=46) Mean (S.E.)		Sibs-TD (*n*=25) Mean (S.E.)	
Proportion Variables	Skewness	Kurtosis	Skewness	Kurtosis	Skewness	Kurtosis
Rate SPA/ Total Rate SA	1.30 (.285)	1.68 (.563)	1.30 (.350)	**2.11 (.688)**	1.40 (.464)	1.52 (.902)
Time SPA/ Total Time SA	1.95 (.285)	**4.85 (.563)**	**2.20 (.350)**	**6.93 (.688)**	1.69 (.464)	**2.90 (.902)**
Rate SPA/ Total Rate PA	.153 (.285)	-.199 (.563)	.473 (.350)	.187 (.688)	-.424 (.464)	-.483 (.902)
Time SPA/ Total Time PA	1.04 (.285)	.972 (.563)	1.53 (.350)	**2.67 (.688)**	.388 (.464)	-.436 (.902)

Each of the demographic variables was then correlated with the study's dependent variables of interest to determine whether these demographics could influence later analyses. Chronological age, mental age, and race were not found to be correlated with any of the dependent variables of interest; therefore these demographic variables were not considered as covariates in subsequent analyses. Gender and maternal education were significantly correlated with multiple dependent variables. These correlations are included in Table 7 below.

It is important to note that, for the purposes of statistical analyses, the male gender was given a code of 1 and the female gender was given a code of 2; therefore, positive correlations would relate to relatively higher scores on the dependent variables for females and negative correlations would relate to relatively higher scores on the dependent variables for males. In addition, maternal education levels were coded as ordinal variables from lowest to highest with 7 levels (i.e., lowest maternal education level of less than 7 years of education was ranked as 1; highest maternal education of graduate degree was ranked as 7). All mothers had at least a high school education (level 4). Positive correlations would indicate that higher levels of maternal education are related to higher levels of the dependent variables and conversely, negative correlations would indicate that lower levels of maternal education are related to higher levels of the dependent variables. Given that maternal education was also significantly different between groups, partial correlations were used to determine whether the correlations between maternal education and the dependent variables would remain after controlling for differences between groups. Partial correlations revealed that all significant correlations between maternal education and the dependent variables remained after controlling for group. Therefore, gender, and maternal education were considered as covariates in subsequent analyses as appropriate.

Table 7. Summary of Significant Correlations between Demographics and Dependent Variables

Dependent Variable	Gender *r* (*p*)	Maternal Education *r* (*p*)
Total PA		
Rate	-.277 (.019)	-.240 (.044)
Time	-.280 (.018)	-.243 (.041)
SPA		
Rate	-	-.240 (.044)
NSS		
Rate	-.340 (.004)	-.251 (.035)
Time	-.272 (.022)	-.277 (.019)
Average Duration	-	-.266 (.025)
Proportion Variables		
Rate SPA/Total SA	-	-.309 (.009)
Time SPA/Total SA	-	-.268 (.024)

Table 8 provides the means and standard deviations for the coded variables (raw scores, not transformed variables). The rate (per second), time, and average duration of occurrence of behaviors are presented. Table 9 provides the means and standard deviations for the calculated proportion variables. The mean duration of the coded STAT sessions was 19.87 minutes (1191.96 seconds), ranging from 10.30 minutes to 30.20 minutes. There were no differences between the groups on the mean duration of Total Time coded from the STAT, $t(69) = 1.283$, $p = .204$, and Total Time was not correlated with group, $r = -.139$, $p = .249$. However, the Sibs-ASD group did show significantly greater variance on total time coded (i.e., larger standard deviation, wider range) than the Sibs-TD group, $F = 4.684$, $p = .034$. Time coded as unobservable ranged from 0% to

5.8% (approximately 1.2 minutes) of the total time (average 0.8%; approximately 0.2 minutes or 12 seconds). Twenty-one participants (30%) had no unobservable time (i.e., 100% of time observable). Unobservable time was included in the calculation of the Total Time sum for analyses. As the duration of Total Time coded was not standardized across participants, only the rate and time variables (with total time as the denominator of the proportion) are used for subsequent analyses.

For the analyses that follow, effect sizes are reported as partial eta squared (η_p^2) or Cohen's *d* values. (Note: partial eta squared is defined as the proportion of the effect + error variance that is attributable to the effect; $\eta_p^2 = SS_{effect} / (SS_{effect} + SS_{error})$). For correlational analyses, the effect size is considered low if the correlation coefficient (*r*), varies around 0.1. medium if *r* is around 0.3, and larger if *r* varies more than 0.5 (Cohen, 1988, 1992).

Table 8. Means and Standard Deviations of Coded Dependent Variables by Group
* Indicates significant group differences ($p \leq .05$)

Group

Variable	Sibs-ASD (*n* = 46) Mean (S.D.)				Sibs-TD (*n* = 25) Mean (S.D.)			
	Frequency	**Rate** (per second)	**Time**	**Average Duration** (seconds)	**Frequency**	**Rate** (per second)	**Time**	**Average Duration** (seconds)
Total SA	53.07 (33.77)	.045 (.029)	.061 (.043)	1.36 (.335)	63.76 (27.33)	.057 (.026)	.081 (.040)	1.41 (.263)
Total PA	22.52 (19.95)	.019* (.017)	.040* (.039)	1.85 (.912)	29.80 (18.77)	.028* (.019)	.050* (.038)	1.66 (.583)
SA-EC	46.74 (30.65)	.040 (.026)	.055 (.040)	1.37 (.350)	54.32 (24.83)	.048 (.023)	.069 (.037)	1.40 (.294)
SPA	6.33 (6.84)	.005* (.006)	.007* (.007)	.896* (.614)	9.44 (7.79)	.009* (.008)	.011* (.011)	1.19* (.527)
NSS	16.20 (13.96)	.014* (.012)	.034 (.034)	2.02 (1.05)	20.36 (12.05)	.019* (.012)	.038 (.030)	1.82 (.693)

Table 9. Means and Standard Deviations of Calculated Proportion Variables by Group
* Indicates significant group differences ($p \leq .05$)

Variable	Sibs-ASD (*n*=46)	Sibs-TD (*n*=25)
Proportion Variables	Mean (s.d.)	Mean (s.d.)
Rate SPA/ Total Rate SA	.123 (.122)*	.152 (.128)*
Time SPA/ Total Time SA	.116 (.133)*	.143 (.138)*
Rate SPA/ Total Rate PA	.213 (.170)	.281 (.135)
Time SPA/ Total Time PA	.145 (.154)*	.220 (.138)*

Analysis of Variance

Hypothesis 1-1: To address the first prediction, a Mixed Model ANOVA using the repeated measures linear model was conducted with Group (two levels: Sibs-ASD and Sibs-TD) as the between-subjects variable and Positive Affect Type (two types: Social/Shared and Non-social) as the within-subjects variable. First the rate variables were tested using the normally distributed transformed variables. Gender and maternal education were entered as covariates. (a) Consistent with prediction, a significant main effect for Group emerged such that the Sibs-TD group displayed a higher rate of Total PA on average than the Sibs-ASD, $F(1,67)=9.779$, $p=.003$, $\eta_p^2=.127$.

(b) Also consistent with prediction, a Univariate ANOVA revealed a significant group difference when SPA was specifically examined, with Sibs-TD showing a higher rate of SPA on average than Sibs-ASD, $F(1,68)=11.466$, $p=.001$, $\eta_p^2 = .144$. (c) In contrast with predictions, a significant group difference was also found when the rate of

NSS was compared, with Sibs-TD also showing relatively higher rates of NSS on average than Sibs-ASD, $F(1,67)=6.283$, $p=.015$, $\eta_p^2= .086$.

(d) Results of the Mixed Model ANOVA also revealed a significant main effect of Positive Affect Type; however it did not occur in the predicted direction. In contrast with prediction, NSS was found to occur at a significantly higher rate on average than SPA, $F(1,67)=12.049$, $p=.001$, $\eta_p^2= .152$. (e) Also in contrast with predictions, no significant Group X Positive Affect Type interaction effect emerged, $F(1,67)=.023$, $p=.880$, $\eta_p^2 = .000$. The graph depicting the Mixed Model ANOVA results testing the rate variables can be found below in Figure 1.

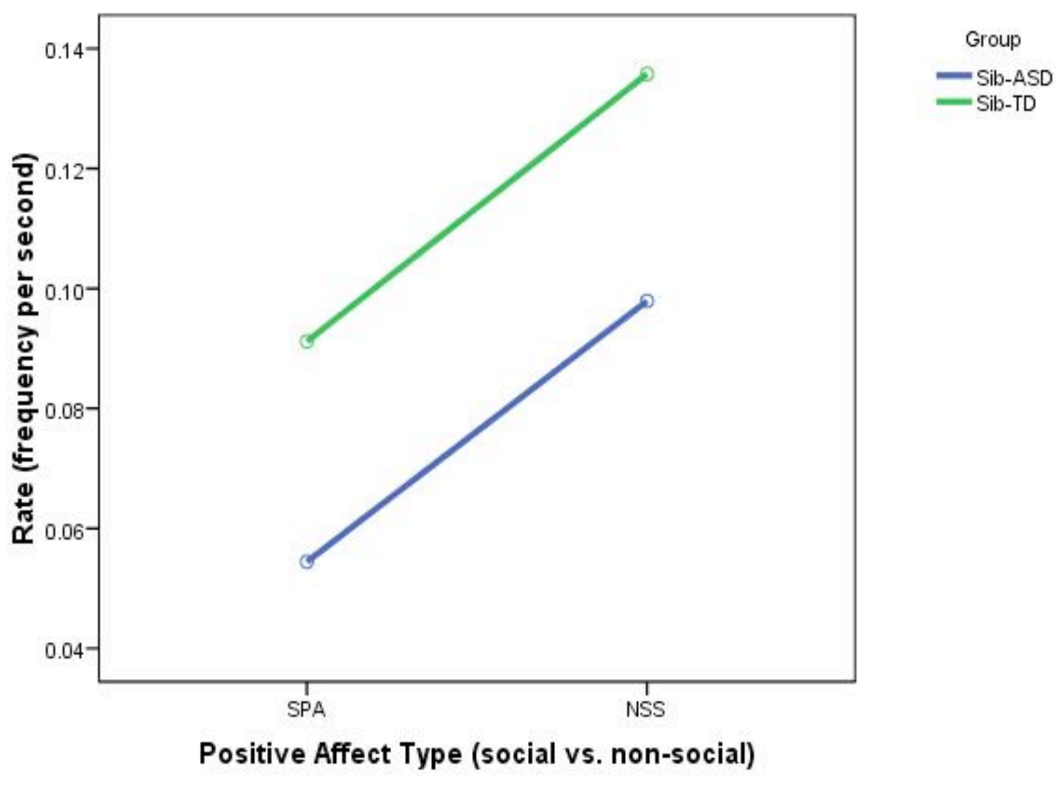

Figure 1. Group by Positive Affect Type Mixed Model ANOVA (Rate)

Similar results were found when the time variables were examined with gender and maternal education as covariates. (a) A significant main effect was found for Group on time of Total PA, $F(1,67)=5.940$, $p=.017$, $\eta_p^2= .081$, (Sibs-TD > Sibs-ASD). (b) Sibs-TD spent more time engaged in SPA on average than Sibs-ASD, $F(1,69)=5.106$, $p=.027$, $\eta_p^2= .069$. (c) In contrast with the previous comparison of rate variables, the time of NSS variables showed no significant differences between the groups, $F(1,67)=3.140$, $p=.081$, $\eta_p^2= .045$. (d) A significant main effect also emerged for Positive Affect Type, $F(1,67)=15.723$, $p=.000$, $\eta_p^2= .190$, again in the opposite direction of the prediction (i.e., NSS > SPA). (e) No significant interaction effect of Group X Positive Affect Type was found, $F(1,67)=.000$, $p=.999$, $\eta_p^2= .000$. These results are depicted below in Figure 2.

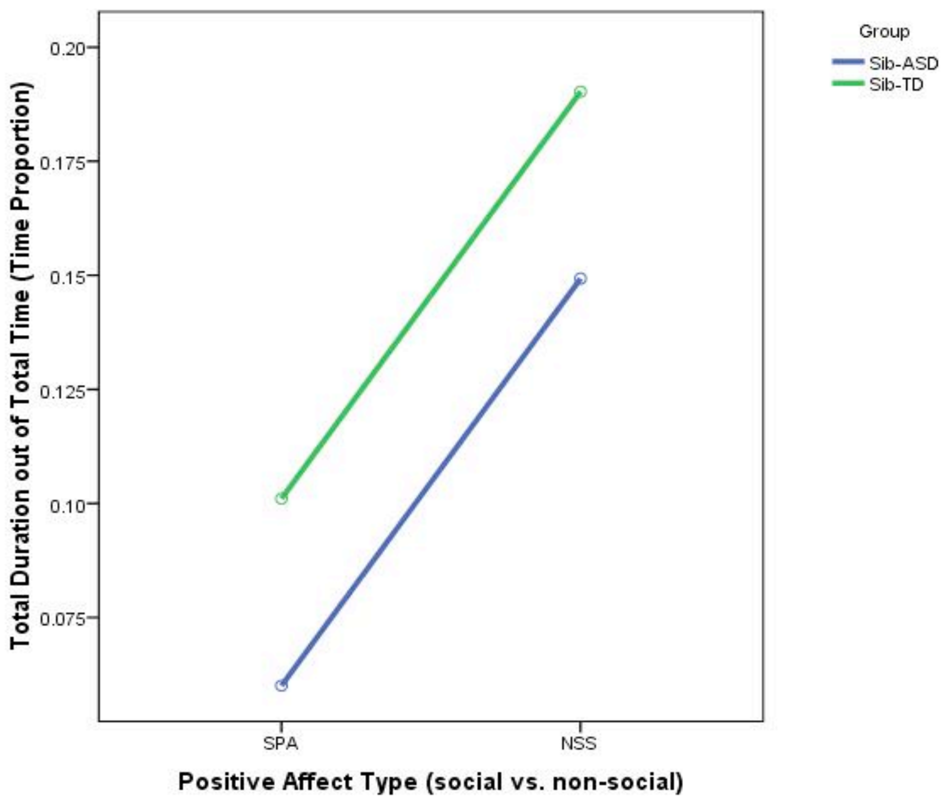

Figure 2. Group by Positive Affect Type Mixed Model ANOVA (Time)

The Mixed Model ANOVA was also used to test the main effects of group and positive affect type as well as their interaction for the average duration variables. These variables were normally distributed, and thus did not require transformation. Maternal education was significantly correlated with the average duration of non-social smiling and thus was entered as a covariate in this model. (a) No significant main effect of Group emerged on the average duration of Total PA, $F(1,68)=0.952$, $p=.333$, $\eta_p^2= .014$. (b) Planned contrasts revealed that groups differed significantly on the average duration of SPA, $F(1,69)=4.040$, $p=.048$, $\eta_p^2= .055$, with Sibs-TD showing longer average duration of occurrences than Sibs-ASD. (c) Groups did not differ on the average duration of NSS occurrences, $F(1,68)=0.005$, $p=.944$, $\eta_p^2= .000$. (d) Results revealed a significant main effect for Positive Affect Type, $F(1,68)=6.542$, $p=.013$, $\eta_p^2= .088$, with NSS occurrences having significantly longer durations on average than occurrences of SPA. (e) The interaction effect of Group X Positive Affect Type was not significant, $F(1,68)=2.271$, $p=.136$, $\eta_p^2= .032$. These results are depicted below in Figure 3.

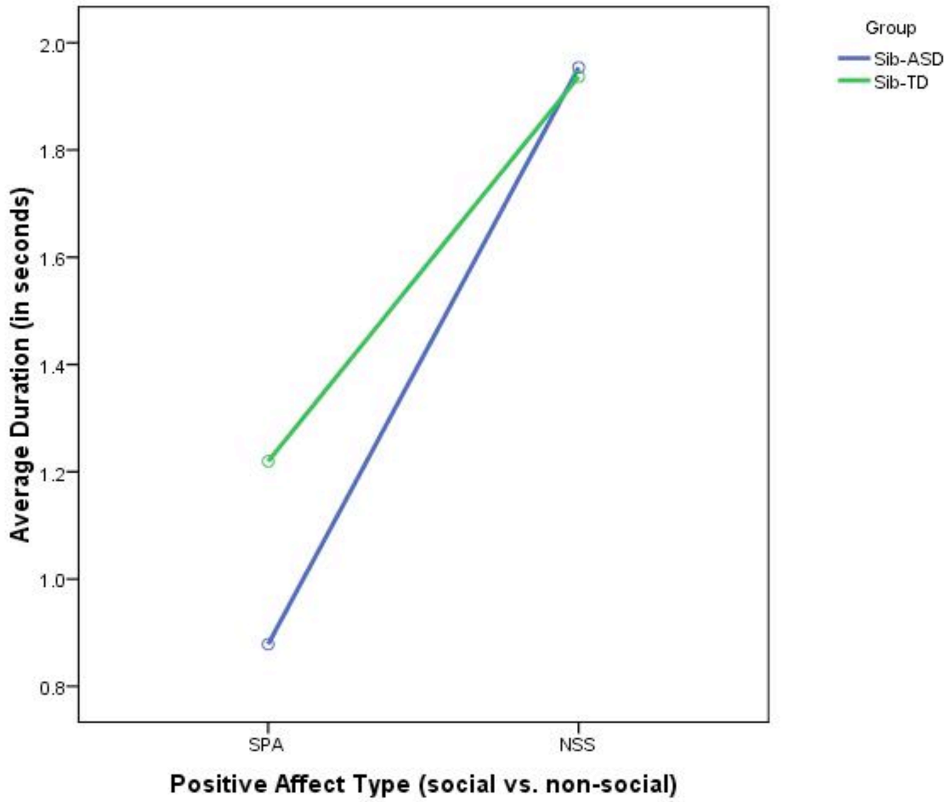

Figure 3. Group by Positive Affect Type Mixed Model ANOVA (Average Duration)

Overall, Sibs-TD showed higher rates and longer total duration (i.e., higher proportion of total time) of positive affect, and particularly shared positive affect, than Sibs-ASD. Occurrences of non-social smiling were significantly more prevalent than occurrences of shared positive affect. In fact, only two participants (3%) showed a higher rate of shared positive affect than non-social smiling (both were females from the Sibs-ASD group).

Hypothesis 1-2: A Univariate ANOVA was run to test the second prediction that Sibs-TD would display greater social attention than Sibs-ASD. In contrast with prediction, no significant differences emerged between the groups on rate of Total SA, *F*(1,69)=2.928, *p*=.092, η_p^2= .041, time of Total SA, *F*(1,69)=3.476, *p*=.067, η_p^2= .048, average duration of Total SA, *F*(1,69)=0.337, *p*=.564, η_p^2= .005, rate of SA-EC, *F*(1,69)=1.810, *p*=.183, η_p^2= .026, time of SA-EC, *F*(1,69)=2.251, *p*=.138, η_p^2= .032, or average duration of SA-EC, *F*(1,69)=0.153, *p*=.697, η_p^2= .002.

Hypothesis 1-3: Groups were then compared on the proportion variables of shared positive affect (SPA) using Univariate ANOVA analyses. (a) The ratio of SPA/Total PA was not close to 1 as predicted, as NSS occurred at a higher rate on average than SPA (as noted above). The mean rate of SPA/Total PA for the whole sample was .237 (s.d.=.161, Range = .000-.700). The mean rate of SPA/Total PA for Sibs-ASD was .213 (s.d.=.170, Range = .000-.700) and for Sibs-TD was .281 (s.d.=.135, Range = .000-.500). The mean time of SPA/Total PA for the whole sample was .172 (s.d.=.152, Range = .000-.679). The mean time of SPA/Total PA for Sibs-ASD was .145 (s.d.=.154, Range = .000-.679) and for Sibs-TD was .220 (s.d.=.138, Range = .000-.495).

No significant difference emerged between groups on the average proportion of rate of SPA/Total PA, *F*(1,69)=2.927, *p*=.092, η_p^2= .041. In contrast, a significant group difference did emerge when comparing the proportion of time of SPA/Total PA, *F*(1,69)=5.924, *p*=.018, η_p^2= .079. Sibs-TD spent a higher proportion of their positive affect time engaged in shared positive affect (rather than non-social smiling) than did Sibs-ASD.

(b) Groups were also compared on the proportion of SPA/Total SA. Similar to the results comparing positive affect types, paired samples t-tests revealed that SPA also occurred less frequently than SA-EC, *t*(70)=16.857, *p*=.000, Cohen's *d*= 4.03, and at a lower time proportion than SA-EC, *t*(70)=15.818, *p*=.000, Cohen's *d*= 3.78.

The mean rate of SPA/Total SA for the whole sample was .133 (s.d.=.124, Range = .000-.552). The mean frequency of SPA/Total SA for Sibs-ASD was .123 (s.d.=.122, Range = .000-.552) and for Sibs-TD was .152 (s.d.=.128, Range = .000-.485). The mean time proportion of SPA/Total SA for the whole sample was .126 (s.d.=.134, Range = .000-.690). The mean time proportion of SPA/Total PA for Sibs-ASD was .116 (s.d.=.133, Range = .000-.690) and for Sibs-TD was .143 (s.d.=.138, Range = .000-.571). Only one participant (male Sibs-ASD with high overall rate of positive affect) was found to display more occurrences of SPA than social attention alone, and only two participants (one male Sibs-TD and the aforementioned male Sibs-ASD) showed a higher proportion of time spent engaged in SPA than in social attention alone.

Consistent with the predicted hypothesis, results of the Univariate ANOVA (controlling for maternal education) revealed that Sibs-TD showed a higher proportion of SPA/Total SA than Sibs-ASD, both for the rate of SPA/Total SA, $F(1,68)=7.607$, $p=.007$, $\eta_p^2 = .101$, and the time proportion of SPA/Total SA , $F(1,68)=5.541$, $p=.021$, $\eta_p^2= .075$.

Overall, Sibs-TD were found to be more likely than Sibs-ASD on average to display positive affect while looking to a social partner. In contrast, no difference emerged between groups in the frequency of positive affect (i.e., smiles) that were coordinated with social attention. However, Sibs-TD were found to spend a greater proportion of time on average than Sibs-ASD engaged in shared positive affect (i.e., coordinating smiling with eye contact) during the time that positive affect was displayed.

Shared Positive Affect and Parent Reported Social Engagement

Descriptive statistics and Univariate ANOVA tests were run to compare the groups on the parent-reported measure of social engagement. The mean, standard deviation, and range for the DAISI Total Score, DAISI Dyadic Score, and DAISI Triadic score are reported by group below in Table 10, with higher scores indicating relatively higher levels of social engagement. The DAISI Total Score was found to correlate significantly with the demographics of maternal education, r = .264, p = .026, and Time 1 mental age, r = .387, p = .001. The DAISI Dyadic Score was found to correlate with maternal education, r = .320, p = .007. The DAISI Triadic Score was significantly correlated with Time 1 chronological age, r = .254, p = .033, and Time 1 mental age, r = .449, p = .000. Univariate ANOVA tests revealed that groups differed significantly on the DAISI Total Score, $F(1,67)=3.990$, $p=.050$, $\eta_p^2= .056$ and the DAISI Dyadic Score, $F(1,68)=5.855$, $p=.018$, $\eta_p^2= .079$, with Sibs-TD showing higher levels of parent-reported social engagement on average than Sibs-ASD. No significant group differences were found for the DAISI Triadic Score, $F(1,67)=.923$, $p=.340$, $\eta_p^2= .014$.

Table 10. Descriptive Statistics for the DAISI

	Group			
	Sibs-ASD (*n*=46)		Sibs-TD (*n*=25)	
Social Engagement Scale from the DAISI	Mean (s.d.)	Range	Mean (s.d.)	Range
DAISI Total Score (15 critical items)	12.85 (2.50)	4-15	14.40 (1.08)	11-15
DAISI Dyadic Score (10 items)	8.78 (1.50)	4-10	9.76 (0.52)	8-10
DAISI Triadic Score (5 items)	4.07 (1.48)	0-5	4.64 (0.76)	2-5

Hypothesis 1-4: Pearson bivariate correlations (using partial correlations to control for maternal education, gender, mental age, and/or chronological age as needed) were conducted to test for the relation of the social attention and positive affect dependent variables with the concurrent measure of parent-reported social engagement. All social attention and positive affect dependent variables (i.e., rate, time, average duration, and proportion) were tested both for the whole sample and within the groups against the three variables from the DAISI (Total Score, Dyadic Score, and Triadic Score).

(a) Four significant correlations emerged within the whole sample, with total smiles and non-social smiling variables correlating with the DAISI Dyadic Score as follows: rate of Total PA, $r = .249$, $p = .039$, rate of NSS, $r = .292$, $p = .015$, time of NSS, $r = .313$, $p = .009$, and the average duration of NSS, $r = .243$, $p = .042$. In direct contrast with prediction, shared positive affect and social attention variables were not found to significantly correlate with concurrent parent reported social engagement.

(b) Several significant correlations emerged within the Sibs-ASD group. The time of SPA was found to correlate significantly and negatively with the DAISI Triadic score $r = -.319$, $p = .035$. The time proportion of SPA/Total SA was also significantly and negatively correlated with the DAISI Triadic score, $r = -.339$, $p = .026$. The rate of NSS, $r = .292$, $p = .015$, and the time of NSS, $r = .313$, $p = .009$, were also significantly correlated with the DAISI Dyadic score within the Sibs-ASD group. No significant correlations were found within the Sibs-TD group. In contrast with prediction, Fishers' z-tests revealed no significant differences between groups on the relative strengths of the correlations, with p-values ranging from .085 to .619.

Levene's test for the equality of variances did confirm the hypothesis that the groups differed significantly on the variances of the DAISI Total score, $F = 8.175$, $p = .006$, the DAISI Dyadic Score, $F = 17.614$, $p = .000$, and the DAISI Triadic Score, $F = 10.822$, $p = .002$. As predicted, Sibs-ASD showed a higher variance (i.e., greater variability) on all three DAISI social engagement scores than did Sibs-TD. In contrast with predictions, no significant differences emerged between groups on the variance of shared positive affect variables (*p* values range from .084-.911).

Shared Positive Affect and Outcome Autism Symptomatology Measures

Hypothesis 2: Pearson bivariate correlations were conducted to assess the relation of coded shared positive affect variables at Time 1 with measures of autism symptomatology at Time 2. Correlations between shared positive affect codes and follow-up CARS scores were run for the whole sample as well as within groups. Correlations between shared positive affect codes and follow-up ADOS scores were run only within the Sibs-ASD group (as ADOS scores were not available for the Sibs-TD group). Descriptives for the Time 2 CARS and ADOS scores are presented in Table 11 below. All rate, time, average duration, and proportion variables were run through the correlation analyses.

Table 11. Descriptives for Outcome Autism Symptomatology Measures

Note: Sixteen participants (38%) received ADOS Module 1 and 26 participants (62%) received ADOS Module 2. Both Modules' Total Scores can range from 0-24. Cutoff for ASD is 7 (12 for autism) for Module 1 and 8 (12 for autism) for Module 2.

	Group			
	Sibs-ASD (*n*=42)		Sibs-TD (*n*=25)	
Autism Symptomatology Measures at Time 2	Mean (s.d.)	Range	Mean (s.d.)	Range
CARS Total Score (Possible range =15-60)	19.85 (5.07)	15-40	16.30 (1.73)	15-22
ADOS Total Score	5.76 (4.87)	0-20	-	-
ADOS Communication Score	2.48 (1.80)	0-6	-	-
ADOS Reciprocal Social Score	3.29 (3.37)	0-14	-	-
ADOS Social Affect Score	5.12 (4.64)	0-20	-	-
ADOS Restricted and Repetitive Behavior Score	0.90 (1.23)	0-5	-	-
ADOS Social Affect + Restricted and Repetitive Behavior Total Score	6.02 (5.53)	0-24	-	-

A t-test comparing the groups on Total CARS score revealed a significant difference between the groups with Sibs-ASD showing higher Total CARS scores (i.e., more autism symptomatology) on average than Sibs-TD, $t(65)=4.145$, $p = .000$, Cohen's $d= 1.028$. Levene's test for the equality of variances also revealed significantly more variability within the Sibs-ASD group as compared to the Sibs-TD group, $F = 13.184$, $p = .001$.

When conducted for the whole sample, results from correlational analyses revealed only one significant negative correlation between the rate of SPA at Time 1 and Total CARS score at Time 2, $r = -.283$, $p = .021$. In contrast with prediction, correlational analyses run within groups revealed that the rate of SPA was only correlated with the later CARS score in the Sibs-TD group, $r = -.408$, $p = .048$, but not within the Sibs-ASD group, $r = -.148$, $p = .353$.

Fisher's *z* test was used to compare the relative strength of the correlations between groups. The *z* test revealed that the groups did not differ significantly on the strength of the correlation between the rate of SPA and later CARS score, $z = 1.062$, $p = .288$.

Correlational analyses run within groups also revealed that the proportion of SPA/Total PA was correlated with the later CARS score within the Sibs-TD group, $r = -.398$, $p = .049$, but not within the Sibs-ASD group, $r = -.078$, $p = .622$. Once again, however, Fisher's *z* test revealed that the groups did not differ significantly on the strength of these correlations, $z = 1.287$, $p = .198$. No other significant correlations between Time 1 shared positive affect variables and later CARS score were found either within groups or for the whole sample.

The ADOS Module was significantly correlated with all of the ADOS Total and subscale scores (*p*-values ranging from .003 to .043) except for ADOS Communication ($p=.947$). Therefore, ADOS Module was included as a covariate in partial correlational analyses (bivariate correlational analyses used for ADOS Communication score). Table 12 below outlines the results of the ADOS correlational analyses. None of the social attention variables (Total SA or SA-EC) were correlated with ADOS scores. The rate of Total PA was correlated with all ADOS scores except Communication and Restricted Repetitive Behavior (RRB). The time and average duration of Total PA were not correlated with any ADOS scores. The rate of SPA was significantly negatively correlated with all ADOS scores except RRB. The average duration of SPA correlated with ADOS Communication, but none of the other ADOS scores. The SPA time variable was not significantly correlated with any ADOS scores. The rate of NSS was significantly negatively correlated with the ADOS Social Affect score. The NSS time variable was significantly correlated with all ADOS variables except RRB and the sum of Social Affect + RRB. None of the calculated SPA proportion variables correlated with ADOS scores.

Table 12. Significant Correlations between ADOS Scores and Coded Variables

	ADOS Scores					
Coded Variables	Total *r* (*p*)	Comm. *r* (*p*)	Rec. Social *r* (*p*)	Soc. Affect *r* (*p*)	Res. Rep. Beh *r* (*p*)	Soc. Aff + RRB *r* (*p*)
Total SA	All correlations non-significant (*ns*)					
Total PA						
Rate	-.315 (.045)	*ns*	-.320 (.042)	-.381 (.014)	*ns*	-.321 (.041)
Time	All *ns*					
Avg. Dur.	*ns*	-.307 (.048)	*ns*	*ns*	*ns*	*ns*
SA-EC	All *ns*					
SPA						
Rate	-.346 (.027)	-.341 (.027)	-.320 (.042)	-.371 (.017)	*ns*	-.341 (.029)
Time	All *ns*					
Avg. Dur.	*ns*	-.333 (.031)	*ns*	*ns*	*ns*	*ns*
NSS						
Rate	*ns*	*ns*	*ns*	-.362 (.020)	*ns*	*ns*
Time	-.332 (.034)	-.312 (.044)	-.318 (.043)	-.362 (.020)	*ns*	*ns*
Avg. Dur.	All *ns*					
Proportion Variables	All *ns*					

Outcome Diagnostic Information

At the Time 2 evaluation, six Sibs-ASD participants (6/42 Sibs-ASD, 14%; 6/67 Total, 9%) received autism spectrum disorder diagnoses, including 3 participants receiving a diagnosis of autism and 3 participants receiving a diagnosis of PDD-NOS. An additional 9 Sibs-ASD participants (9/42 Sibs-ASD, 21%; 9/67 Total, 13%) were characterized as having features of the broader autism phenotype (BAP). No participants in the Sibs-TD group received ASD diagnoses and none were characterized as having broader autism phenotype features.

All univariate ANOVA analyses that previously showed significant differences between the Sibs-ASD and Sibs-TD group were re-run, first excluding those participants that received an ASD diagnosis at outcome, and second excluding both the children with an ASD diagnosis and the children in the BAP group. Table 13 summarizes the results (means, standard deviations, and *p*-values from Univariate ANOVA group comparisons) both before and after these participants were removed. All group differences remained significant when only the ASD participants were removed. In contrast, only 5 out of the original 8 group differences remained when ASD and BAP participants were removed.

Table 13. Coded Dependent Variable Descriptives with and without ASD and/or BAP Participants Included

Coded Variable	**Sibs-ASD**			**Sibs-TD (*n*=25)**
	Full Sample (*n*=46)	**ASD Participants Removed (*n*=40)**	**ASD + BAP Participants Removed (*n*=31)**	
Rate of Total PA Mean (s.d)	.019 (.017)	.019 (.017)	.020 (.017)	.028 (.019)
p-value	**.007**	**.010**	**.039**	
Rate of SPA Mean (s.d)	.005 (.006)	.005 (.006)	.006 (.006)	.009 (.008)
p-value	**.001**	**.002**	**.011**	
Time of SPA Mean (s.d)	.007 (.007)	.006 (.007)	.007 (.007)	.011 (.011)
p-value	**.027**	**.027**	.092	
Average Duration of SPA Mean (s.d)	.896 (.614)	.878 (.620)	.942 (.604)	1.19 (.527)
p-value	**.048**	**.042**	.115	
Rate of NSS Mean (s.d)	.014 (.012)	.013 (.011)	.014 (.011)	.019 (.012)
p-value	**.015**	**.017**	**.050**	
Time SPA/Time Total PA Mean (s.d)	.145 (.154)	.143 (.159)	.164 (.171)	.220 (.138)
p-value	**.018**	**.016**	.074	
Rate SPA/Total SA Mean (s.d.)	.123 (.122)	.115 (.106)	.115 (.099)	.152 (.128)
p-value	**.007**	**.006**	**.009**	
Time SPA/Time Total SA Mean (s.d.)	.116 (.133)	.106 (.105)	.104 (.096)	.143 (.138)
p-value	**.021**	**.013**	**.019**	

Descriptive information for the six participants who received ASD diagnoses at the outcome evaluation is presented in Table 14 below. It is interesting to note that the one female participant who received a diagnosis of autism made the least gains in cognitive skills (i.e., smallest increase in mental age) compared to the other ASD participants. A graph depicting the relative proportion of social and non-social smiling (out of total positive affect) for each participant with an ASD diagnosis is provided below in Figure 4. Only 1 out of the 6 participants with an ASD diagnosis had no coded occurrences of smiling. The remaining 5 of the 6 participants with an ASD diagnosis showed relatively higher rates of non-social smiling than shared positive affect. For comparison purposes, the average proportions of SPA and NSS for the non-ASD Sibs and Sibs-TD are also included in Figure 4. As seen in the graph, both of these groups, on average, also showed a trend for higher rates of NSS than SPA. A difference score variable subtracting SPA from NSS was calculated and the ASD participants were compared to the rest of the sample to assess the significance of the relative difference. ASD participants did not differ from the rest of the sample on the relative difference between NSS and SPA, $F(68)=.003$, $p=.954$.

The relative proportion of social attention with and without coordinated smiling for each participant with an ASD diagnosis is depicted in Figure 5. Five out of the 6 participants with an ASD diagnosis displayed a relatively higher proportion of social attention-eye contact alone than shared positive affect. The remaining participant had 55% of total social attention occurring as shared positive affect episodes. This participant was noted to have relatively high levels of baseline positive affect (i.e., frequent social and non-social smiling throughout STAT), was non-verbal at Time 1, and was observed to frequently display high-pitched non-word vocalizations. Comparison groups of non-ASD Sibs-ASD and Sibs-TD are included in Figure 5. As seen in the graph, most participants tended to display higher rates of SA-EC compared to SPA. Again, a difference score subtracting SPA from SA-EC was created and ASD participants were compared to the remaining sample on this variable. ASD participants did not differ from the remaining sample on this difference score, $F(69)=2.224$, $p=.140$.

The Procoder files for these participants were examined for any notes and comments recorded by the coders. The following noteworthy comments were found within these files: “Child seemed to look at the examiner’s mouth a lot,” “Child looks up but not at the eyes,” “Lack of eye contact and smiles during the snack,” “Very vocal child,” “Unsure if smiling or distressed,” “High pitch squeal sound,” “Child very active,” “Eye contact unclear,” and “Smile unclear.” The majority of comments appeared to relate to unclear or otherwise atypical occurrences of social attention and positive affect.

Table 14. Descriptives for Participants with an ASD Diagnosis

Participant	Diagnosis	CA (months)		MA (months)		Gender	Developmental Delay?
		Time 1	Time 2	Time 1	Time 2		
1	PDD-NOS	18	37	14.5	24	Male	Yes
2	Autism	13	31	13	23	Male	Yes
3	PDD-NOS	13	31	11.25	32.5	Male	No
4	PDD-NOS	12	31	14.25	26.75	Male	No
5	Autism	12	34	10.5	17.5	Male	Yes
6	Autism	13	31	12	12.5	Female	Yes

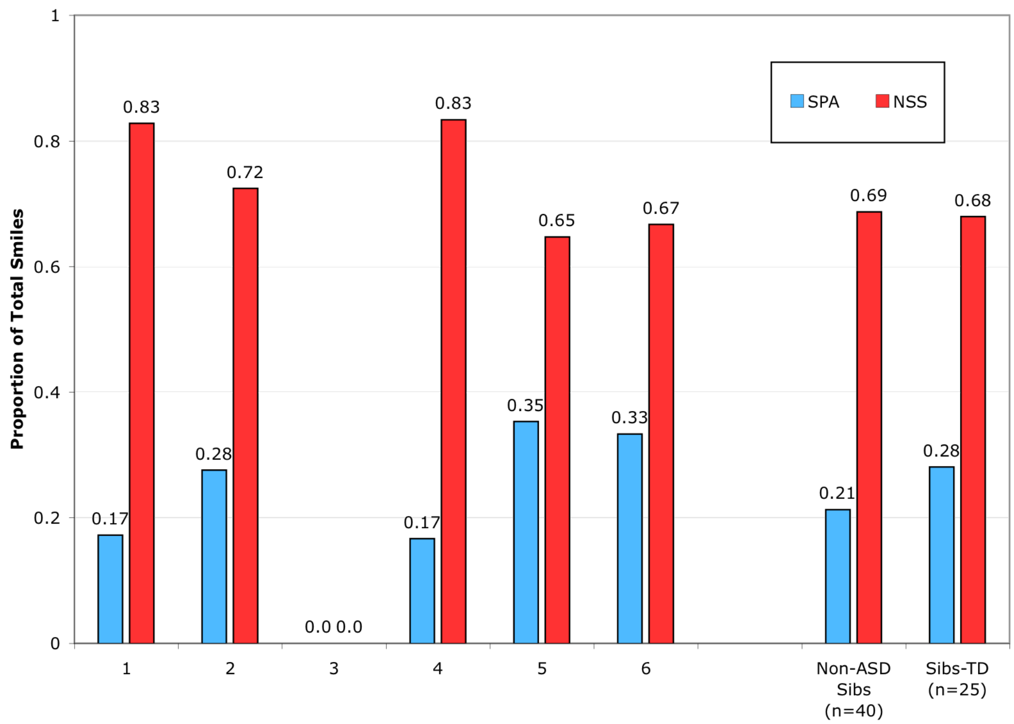

Figure 4. Relative Proportion of Social and Non-Social Smiling Across Participants

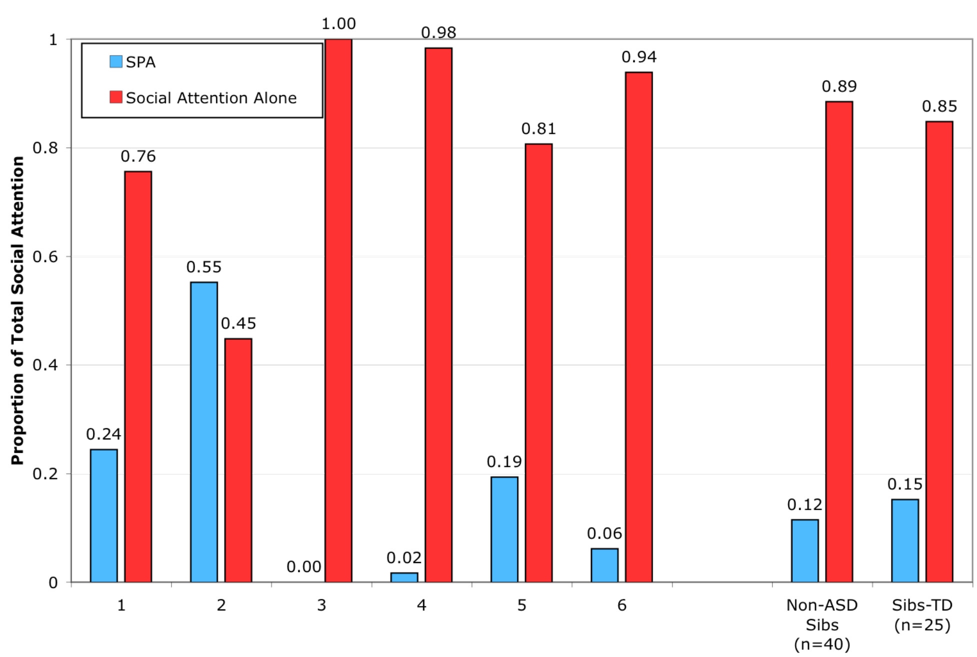

Figure 5. Relative Proportion of SPA and Social Attention Across Participants

Post-Hoc Analyses

Given that gender was found to significantly correlate with several of the coded dependent variables, additional Univariate ANOVA analyses (controlling for covariates of group and/or maternal education as applicable) were conducted to compare all of the coded variables across gender. A significant gender difference was found for Total PA, with males showing a higher rate of Total PA, $F(1,67)=4.255$, $p=.043$, $\eta_p^2= .060$, and a higher time of Total PA, $F(1,68)=5.295$, $p=.024$, $\eta_p^2= .072$, than females. This difference appeared to be due to males showing a higher rate of NSS, $F(1,67)=7.328$, $p=.009$, $\eta_p^2= .099$, and a higher time of NSS, $F(1,68)=4.904$, $p=.030$, $\eta_p^2= .067$, than females. No gender differences emerged when comparing SPA, Total SA, or SA-EC variables.

STAT Total Score was significantly correlated with chronological age at Time 1, $r = -.461$, $p = .000$, and Time 2, $r = -.255$, $p = .037$. Univariate ANOVA analyses, controlling for chronological age, revealed a significant group difference on Time 1 STAT Score, $F(1,68)=7.877$, $p = .007$, with Sibs-ASD having a higher mean STAT Total Score (i.e., more impaired social-communicative performance) than Sibs-TD. No group differences emerged on Time 2 STAT Score, $F(1,64)=.004$, $p = .950$.

Pearson bivariate correlations (using partial correlations to control for group, chronological age, maternal education and/or gender as applicable) were run to compare the relation of the coded dependent variables with the STAT Total Score at Time 1 and Time 2. Correlations with the Time 1 STAT Total Score are reported in Table 15. Results revealed that all positive affect variables (i.e., Total PA, SPA, NSS) were significantly correlated with STAT Total Score within the whole sample at Time 1. The Total SA and SA-EC variables were not significantly correlated with Total STAT Score at Time 1. Correlations varied within groups, but Fisher's *z*-tests confirmed that the relative strength of correlations did not differ between groups (all *p* values > .10).

No correlations were significant between the coded dependent variables and Time 2 STAT Total Score within the whole sample. When examined within groups, the time and average duration of SA-EC were found to correlate significantly with Time 2 STAT Total Score within the Sibs-ASD group, $r = -.346$, $p = .027$ and $r = -.323$, $p = .040$, respectively. The relative strength of the correlations did not differ between groups (both *p*-values > .10). Additionally, the time of SPA correlated with the Time 2 STAT Total Score within the Sibs-TD group, $r = -.422$, $p = .045$. The strength of the correlation within the Sibs-TD group was found to be significantly greater than the correlation within the Sibs-ASD group, z=2.27, p=.023.

Table 15. Correlations between Coded Variables and Time 1 STAT Score

	Whole Sample (*n*=71) *r* (*p*)	Sibs-ASD (*n*=46) *r* (*p*)	Sibs-TD (*n*=25) *r* (*p*)
Total PA			
Rate	**-.258 (.041)**	-.196 (.231)	-.380 (.081)
Time	**-.329 (.008)**	-.280 (.085)	**-.459 (.032)**
Average Duration	**-.287 (.020)**	**-.313 (.046)**	-.303 (.149)
Total SA			
Rate	-.052 (.680)	-.053 (.742)	-.047 (.826)
Time	.008 (.951)	-.031 (.848)	.101 (.639)
Average Duration	.072 (.571)	.019 (.907)	.238 (.262)
SA-EC			
Rate	-.026 (.835)	-.036 (.825)	.005 (.980)
Time	.026 (.839)	-.019 (.904)	.140 (.515)
Average Duration	.056 (.656)	.002 (.991)	.221 (.300)
SPA			
Rate	**-.288 (.021)**	-.263 (.101)	-.377 (.076)
Time	**-.248 (.048)**	-.225 (.163)	-.344 (.108)
Average Duration	**-.298 (.016)**	**-.315 (.045)**	-.268 (.205)
NSS			
Rate	**-.298 (.018)**	-.224 (.171)	**-.459 (.032)**
Time	**-.410 (.001)**	**-.362 (.024)**	**-.560 (.007)**
Average Duration	**-.399 (.001)**	**-.429 (.006)**	**-.420 (.046)**

CHAPTER V

DISCUSSION

Affect sharing plays an integral role in regulating social interactions throughout development, beginning with the early face-to-face dyadic interactions that take place between a parent and child. Autism is a neurodevelopmental disorder that can provide particularly important information to the study of social-emotional skills and positive affect sharing. Children with autism spectrum disorders (ASDs) are known to have impairments in their ability to engage in social interactions, make eye contact, and share affect with others.

The population of at-risk Sibs-ASD provides a particularly promising opportunity to learn more about social-emotional development broadly, and shared positive affect specifically. The existing literature supports the possibility that positive affect sharing and related behaviors are impaired in at-risk siblings and/or infants who receive a later diagnosis of ASD. Several studies have shown that infants with ASD or at-risk for ASD often demonstrate early impairments in eye contact, attention to faces or people (i.e., social interest), shifting of visual attention, social smiling, joint attention, and orienting to name as well as atypicalities in temperament (e.g., high negativity, difficult to soothe) and emotional expressivity (Bryson et al., 2007; Cassel et al., 2007; Ibanez, et al., 2008; Merin et al., 2007; Presmanes et al., 2007; Sullivan et al., 2007; Yirmiya et al., 2006; Zwaigenbaum et al., 2005). The population of Sibs-ASD allows the unique advantage of prospectively studying early risk markers for autism.

Shared positive affect (SPA) is a behavior that emerges early and is readily observable in typically developing infants. Therefore, positive affect sharing may be a good experimental variable to investigate in the search for early behavioral markers of autism, as it is expected to emerge earlier in development than the joint attention behaviors that are commonly the focus of current early screening tools (Swinkels et al., 2006). Additionally, the temporal coordination of smiling with other behaviors, such as gaze to a social partner as in positive affect sharing, is an important developmental milestone for infants (Yale et al., 2003) and may be particularly important to investigate as it relates to early behavioral symptoms of autism (Clifford, Young, & Williamson, 2007).

From the current literature, the developmental significance of positive affect sharing as a unique independent construct remains somewhat unclear. For example, it is unknown whether positive affect sharing plays a causal or mediating role within the developmental transition from dyadic to triadic social skills. It is possible that different forms of positive affect sharing (i.e., responsive social smiling vs. anticipatory smiling) may be differentially related to later developmental skills (e.g., responding vs. initiating joint attention). Some researchers have begun to examine the developmental trajectories and developmental correlates of positive affect sharing (e.g., anticipatory smiling) in typically developing infants (Jones and Hong, 2001, 2005; Parlade et al., 2009; Venezia et al., 2004). An important goal for researchers will be to determine how positive affect sharing uniquely influences and relates to development in both typically and atypically developing children.

The purpose of the current study was to (1) examine group differences between younger at-risk siblings of children with ASD (Sibs-ASD) and a control group of younger siblings of typically developing children (Sibs-TD) on the construct of shared positive affect and its behavioral components (i.e., social attention-eye contact and positive affect/smiling) and (2) to examine how the construct of positive affect sharing relates to outcome measures of autism symptomatology. The purpose of this research was to further investigate shared positive affect behaviors in the specified populations and to examine whether these behavioral constructs may be useful to consider in early screening and diagnosis of autism spectrum disorders.

The first hypothesis that Sibs-TD would demonstrate more overall positive affect than Sibs-ASD was examined by comparing the groups on the total rate, total time, and average duration of coded positive affect displays. Specifically, it was expected that Sibs-TD would show higher rates of shared positive affect but not non-social smiling. Consistent with prediction, results revealed that Sibs-TD showed a higher rate and longer total time engaged in positive affect displays than Sibs-ASD. Also as predicted, Sibs-TD showed a higher rate and longer total time engaged in shared positive affect than Sibs-ASD. In contrast with prediction, Sibs-TD displayed a higher rate of non-social smiling than Sibs-ASD and occurrences of non-social smiling were found to occur more frequently than occurrences of shared positive affect overall (i.e., for both groups). When comparing the average duration of occurrences of smiles, the groups differed on the average length of shared positive affect displays, with Sibs-TD showing longer duration occurrences on average than Sibs-ASD; no difference between groups was found on the average duration of non-social smiling occurrences or on the total time of non-social smiling.

Taken together, these results are consistent with the literature in suggesting that Sibs-ASD show reductions in positive affect and social smiling compared to typically developing controls (Cassel et al., 2007; Zwaigenbaum et al., 2005). It was unexpected that non-social smiling would occur more frequently than shared positive affect, given the literature noting how positive affect is often observed during social exchanges. These results suggest that perhaps an overall tendency toward positive affectivity (e.g., temperament style) in addition to the specific coordination of positive affect with social attention (i.e., shared positive affect) may differentiate siblings at-risk for ASD from typically developing controls. In addition these results suggest that examining both the frequency and duration of positive affect displays should be considered when examining these behaviors as they may both provide unique information (e.g., differentiating a child who smiles often but each occurrence is brief vs. a child who displays a few sustained occurrences) and may both differentiate at-risk siblings from typically developing siblings.

In contrast with the second prediction and literature suggesting that younger at-risk siblings or children who go on to receive a diagnosis of ASD show reduced levels of eye contact (e.g., Bryson et al., 2007; Clifford et al., 2007; Dawson et al., 2000), no significant differences emerged between the groups on the rate, time, or average duration of total social attention or social attention-eye contact. This suggests that Sibs-ASD and Sibs-TD in the second year of life may show similar levels of eye contact to an adult on average. Some studies in the literature have found similar results with no group differences in the duration of attention to face (e.g., Ibanez et al., 2008). It is important to note that the STAT is a structured, standardized context during which the adult examiner often organizes the interaction for the child. Under these conditions, children with autism have been shown to improve in their social-affective behaviors (Bieberich & Morgan, 1998; Joseph & Tager-Flusberg, 1997; McMahon, 2006). In addition, these results suggest that positive affect, and specifically the coordination of positive affect with eye contact, may be a more discriminating and sensitive behavior than eye contact alone to consider for early screening measures for autism risk.

Shared positive affect was then examined as a proportion of total positive affect and social attention to examine its specific effects after controlling for overall levels of eye contact and smiling. SPA was found to occur less frequently than both non-social smiling and social attention-eye contact. Sibs-TD were found to be more likely than Sibs-ASD on average to display positive affect while looking to a social partner (i.e., higher proportion of SPA out of Total Social Attention). No difference emerged between groups in the frequency of positive affect (i.e., smiles) that were coordinated with social attention (i.e., rate of SPA out of Total Positive Affect). However, Sibs-TD were found to spend a greater proportion of time on average than Sibs-ASD engaged in shared positive affect during the time that positive affect was displayed. In summary, Sibs-TD displayed more positive affect while looking at the examiner and also tended to share their smiles with a social partner, that is, children in the Sibs-TD group were more likely on average to coordinate these behaviors together into the unified act of shared positive affect.

Shared positive affect behaviors were then compared to parent-reported social engagement. Parents of Sibs-TD reported higher levels of overall social engagement and dyadic engagement on average than Sibs-ASD, but no group differences emerged on triadic engagement scores. Sibs-ASD also showed greater variability on all parent-reported social engagement scores than did Sibs-TD.

Correlational analyses revealed some inconsistent and unexpected results. Total positive affect and the rate and duration of non-social smiling were positively correlated with parent-reported dyadic social engagement. This may suggest that children who tend to display more positive affect overall (e.g., tendency toward positive temperament) are rated as more socially engaged by parents. The total duration and proportion of shared positive affect out of total social attention was significantly and negatively correlated with parent-reported triadic social engagement. This result was unexpected as it suggests that children who display relatively more acts of joint attention (e.g., showing, giving, pointing out items of interest) show relatively less shared positive affect and vice versa. One possible explanation is that children who are able to accurately utilize more developmentally advanced triadic joint attention behaviors may no longer need to rely on more immature forms of communication (i.e., dyadic nonverbal communication of eye contact and facial expressions) to effectively convey their wants, needs, and interests to others. More research is certainly required to establish the concurrent validity of the coded shared positive affect variables, including using more objective, observable measures in addition to other parent report measures of social engagement that include more extensive questions around a wider variety of social behaviors (e.g., ITSEA – Carter & Briggs-Gowan, 2000; Parlade et al., 2009).

Correlations between the coded shared positive affect behaviors and the STAT Total Scores at Time 1 were also examined to provide another way to assess the concurrent validity of the study's dependent variables of interest. Positive affect variables, both social and non-social, were significantly related to the concurrent STAT Total Score at Time 1 whereas social attention was not related to the STAT Total Score. This result was somewhat surprising given that eye contact is included as a specific scored behavior in several items within the STAT (e.g., requesting items). In contrast, social smiling is only one possible choice for score-able behaviors on the directing attention items on the STAT, and non-social smiling is not considered in the STAT scoring. Similar to the findings for group differences between Sibs-ASD and Sibs-TD, these results may suggest that positive affectivity in general and shared positive affect specifically may be important discriminating behaviors to consider in assessing social-communication performance and screening for autism risk.

The predictive validity of the coded shared positive affect behaviors was then examined by comparing these behaviors with outcome measures of autism symptomatology. Sibs-ASD showed relatively higher levels of autism symptomatology on average as well as more variability on a measure of autism symptomatology (i.e., the CARS) than Sibs-TD. The rate of shared positive affect at Time 1 was significantly and negatively correlated with the Total CARS Score at Time 2. That is, higher levels of initial shared positive affect were related to lower levels of autism symptomatology at follow-up.

Within the Sibs-TD group, the time spent engaged in shared positive affect was significantly and negatively correlated with the STAT Total Score at follow-up. Within the Sibs-ASD group, positive affect variables including both shared positive affect and non-social smiling, correlated with multiple ADOS scores at follow-up. Interestingly, the rate/frequency but not the total time or average duration of shared positive affect correlated with ADOS scores; in contrast, total time of non-social smiling tended to correlate more often with ADOS scores at follow-up than frequency of non-social smiling. This result may, again, point to a trend for general positive affectivity (e.g., more overall time spent smiling, tendency toward positive temperament) being related to lower autism symptomatology. Additionally, the frequency of directing one's positive affect to a social partner may also be uniquely predictive of better social-communicative performance later on. Also of interest is that the only ADOS subscale that did not correlate with any of the coded dependent variables of interest was the Restricted and Repetitive Behavior score. This result makes theoretical sense in that shared positive affect behaviors have known developmental correlations with social, emotional, and communication behaviors but no known or established relationship with stereotyped or repetitive behaviors.

Overall, these results suggest that higher initial levels of shared positive affect are related to better social-communication performance and lower autism symptomatology at follow-up. These results add both predictive and discriminant validity to the study's coded dependent variables of interest and suggest that shared positive affect may be a useful behavioral measure to include in screening tools that assess early risk markers for autism. Both the frequency and duration of shared positive affect behaviors may be important to consider in future studies, however the relative influence and importance of frequency vs. duration remains unclear from the current study.

Results were re-examined excluding participants who received a diagnosis of ASD and those who were classified as having the "broader autism phenotype" (BAP) to examine the relative influence of these participants on the group comparisons. All variables that initially showed differences between the Sibs-ASD and Sibs-TD groups remained significant when the ASD participants were removed. In addition, when both the ASD and BAP participants were removed from the sample, five of the eight initial variables remained significantly different between the groups. This suggests that the participants who went on to receive a diagnosis of ASD were not outliers on the coded behaviors within the Sibs-ASD group and did not, on their own, account for the differences on shared positive affect variables between the Sibs-ASD and Sibs-TD groups. Rather, the groups continued to show differences after these participants were removed, suggesting that shared positive affect may be a stable indicator of subtle autism symptomatology and that impairments in shared positive affect may be related to features of the broader autism phenotype.

Six out of 46 Sibs-ASD participants (13%) received a follow-up diagnosis of ASD. This rate is consistent with literature suggesting that Sibs-ASD are at an increased risk for receiving a diagnosis of ASD and that ASD occurs at higher rates in the Sibs-ASD population than in the general population (Piven et al., 1997; Ritvo et al., 1989; Szatmari et al., 1998). The behavioral profiles of the six participants who received a follow-up diagnosis of ASD were specifically examined. All participants with an ASD diagnosis showed relatively higher rates of non-social smiling than shared positive affect. One of the 6 participants with an ASD diagnosis had no coded occurrences of smiling. Additionally, 5 out of the 6 participants with an ASD diagnosis displayed a relatively higher proportion of social attention-eye contact alone than shared positive affect. The one remaining participant was noted to have relatively high levels of baseline positive affect (i.e., frequent social and non-social smiling throughout STAT). It is important to note that the relative proportions of SPA to NSS and SA-EC was not different for the ASD participants as compared to the rest of the sample on average. Four of the six participants with an ASD diagnosis also had comorbid diagnoses of developmental delay. Anecdotal comments recorded during video coding often related to unclear or otherwise atypical occurrences of social attention and positive affect as well as high levels of activity and atypical vocalizations (e.g., frequent non-word vocalizations, high pitch sound).

An interesting post-hoc finding was that males displayed higher rates of non-social smiling than females, but no gender difference was found for shared positive affect or social attention. This finding might be interpreted within the "extreme male brain theory of autism" presented by Baron-Cohen (2002). This theory postulates that the male brain is often characterized by a relative strength in "systemising" (e.g., logical organization and ordering, identifying rule-based patterns) and a relative weakness in "empathizing" (e.g., theory of mind, attributing mental states to others and appropriately responding to others' affective states). As this pattern is also often seen in the profiles of individuals with autism, Baron-Cohen argued that autism could be considered an extreme form of this common gender difference. It is possible that the results from this study may extend the analogy to the early social-emotional behaviors of young children in that both males (current study) and children with autism have been shown to express higher rates of non-social smiling when compared to socially directed positive affect and/or to control groups (Dawson et al., 1990; Snow, Hertzig, and Shapiro, 1987; Trad et al., 1993). It could be argued, in turn then, that higher relative levels of non-social smiling may be a developmental precursor to later difficulties with "empathizing."

Several researchers have proposed biological or neuropsychological theories that may help to link autism-related deficits in social attention and emotional processing to organic etiologies and brain functioning. Some have suggested that the primary deficit occurs in the attentional system, including difficulty shifting attention between stimuli (Bryson, Wainwright-Sharp, & Smith, 1990; Courchesne et al., 1994; Dawson & Lewy, 1989a, 1989b). Another theory focuses on social-cognitive skills at the level of perception and processing, arguing that the complexity of social stimuli may be difficult for children with autism to process (Dawson & Lewy, 1989a, 1989b; Gergely & Watson, 1999). Recent studies have examined gaze-fixation and eye gaze processing as a broader autism phenotype feature and found brain activation and volume of involved brain areas to be atypical in siblings of individuals with autism spectrum disorders (Dalton et al., 2007; Elsabbagh et al., 2009). Others contend that children with autism may not be "rewarded" by social stimulation at the neuronal or neuro-chemical level and thus they may lack the inherent desire to be socially engaged with others that is so readily observable in typically developing infants (Dawson, et al., 2001; Mundy & Neal, 2001; Schultz, 2005).

One promising line of research that relates the behaviors examined in the current study to the neurobiology of autism involves the study of the amygdala. Altered amygdala activity in individuals with autism has been related to processing eye gaze, faces, and emotions (Baron-Cohen et al., 1999; Dalton et al., 2005; Hadjikhani, et al., 2007; Wang et al., 2004). Recently, amygdala volume was found to be associated with joint attention ability in 4-year-olds with autism (Mosconi et al., 2009). Additionally, the amygdala and closely associated neurological system of the orbitofrontal cortex have been theoretically linked to the self-regulation of social emotional behavior (Bachevalier and Loveland, 2006).

Based on the replicated findings of difficulties in face processing and perception in autism, Schultz (2005) proposed a provocative neuro-developmental model of the social deficits in autism. Schulz argued that the "search for the neurobiological bases of the autism spectrum disorders should focus on the social deficits as they alone are specific to autism and they are likely to be the most informative with respect to modeling the pathophysiology of the disorder" (p.125). Schultz proposed that the social impairments in autism may begin from a localized brain abnormality or dysfunction. Through developmental processes then, this initial vulnerability adversely influences other systems and the cumulative atypical experiences result in the pervasive disorder. In his model, Schulz argued that the initial insult occurs in the social brain, specifically the amygdala, which plays an important role in emotional arousal and the perception of emotionally salient stimuli and is closely tied to the dopaminergic "reward" system in the brain. According to this model, a lesion in the amygdala would cause one to be less rewarded by social-emotional stimulation. Human faces provide the earliest source of social and emotional information and typically developing infants appear to be motivated and rewarded by their experiences and interactions with faces. The argument follows then, that an abnormality in the amygdala may cause an infant to be less rewarded by stimulation provided by faces, thus resulting in faces being less salient and interesting to the infant, who then does not show the typical bias toward attending to faces. With diminished attention to faces, then, the infant will not receive the typical social-emotional expertise that is gained through early face-to-face dyadic interactions. According to Schultz's model, the deprivation of early social experiences resulting from the lesion in the amygdala will subsequently result in faulty wiring of the "social brain" and will ultimately lead to the hallmark social deficits observed in autism spectrum disorders.

Figure 6 was created by the author as a model that depicts the theoretical relation between the construct of shared positive affect and the social-communicative deficits that are the core of the autism diagnosis. This model may help to organize where research should begin in an attempt to more thoroughly understand the developmental importance of positive affect sharing. First, the precursory components of social attention and emotion/affect that may underlie positive affect sharing are outlined as they relate to behavioral symptoms observed in autism. Within social attention, young children with autism have been consistently shown to have poor eye contact, reduced social orienting (particularly in responding to one's name being called), atypical visual fixation patterns and attention to faces, increased attention to nonsocial objects, and gaze aversion. Under the heading of emotional and affective development, children with autism have difficulties with emotional regulation, reduced positive affect, unusual affective expressions, and poor emotional comprehension and processing.

The impaired ability to coordinate social attention and emotion into shared positive affect may impact both the dyadic and triadic levels of social interaction (see Figure 6). A few studies have demonstrated that young children with autism show reduced turn-taking, poor affect attunement, and poor synchrony during one-on-one interactions (Dawson et al., 1990; Trevarthen & Daniel, 2005). Children with autism also demonstrate well-documented impairments in joint attention behaviors, such as referencing an adult in an unfamiliar situation, following an adult's direction of gaze cues to locate an object, or sharing interest by showing an object to another person to direct attention. The results of this study suggest that shared positive affect may be a unique and important area to consider in the development and diagnosis of autism. The ability to coordinate the attentional and affective systems within a social context may be particularly impaired in individuals with autism and can inform studies of neurobiology, behavior, and intervention.

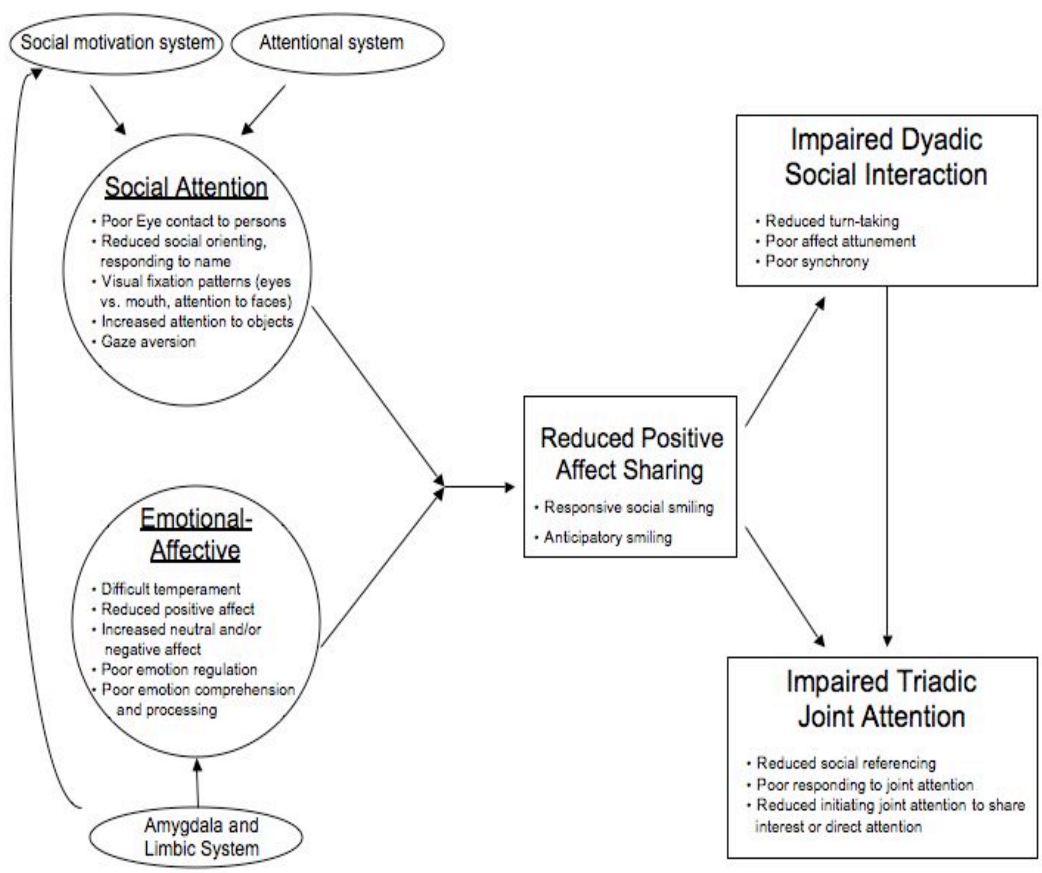

Figure 6. Model of Social-Affective Deficits in Autism

Applying the heuristic model in Figure 6 to Sibs-ASD, it may be that positive affect sharing may provide a good entry point for early intervention targeting social skills. As discussed, children with autism can increase their social smiling during structured reciprocal interactions that are appropriately scaffolded by an adult. If interventions are started at the earliest ages possible (i.e., with at-risk samples such as Sibs-ASD prior to diagnosis), it is possible that increasing positive affect sharing could enhance the quantity and quality of social experiences, thus providing necessary social input where it was previously deprived, and "re-wiring" the social brain to be stimulated and rewarded by more typical experiences of social interaction.

There are several limitations of the current study that are important to consider. First, while the sample size used in the current study is comparable to other studies of younger siblings of children with ASD in the literature (e.g., Cassel et al., 2007, Merin et al., 2007, Zwaigenbaum et al., 2005), the sample size limited the power to detect small and medium effect sizes, particularly when comparing subgroups within the sample. Results from the current study revealed effect sizes primarily in the small to medium range. Therefore, it is critical that these results be replicated with larger samples to ensure that the current findings are not sample specific. In addition, the sample was primarily Caucasian and of relatively high socio-economic status, particularly in the Sibs-TD control group. It will be important to examine shared positive affect in more diverse samples to ensure that the current results can be generalized to other populations. Also, while the primary coder was blind to the participant group (Sibs-ASD vs. Sibs-TD participants), the reliability coder (author C.M.) was not fully blind. Due to limitations of time and location, the reliability coder was solely responsible for resolving disagreements in coding for those tapes selected for reliability coding (i.e., unable to resolve disagreements in coding through consensus with both raters). Therefore, this may have introduced a source of potential bias to the data. However, given the high rates of interrater reliability for the majority of coded behaviors, it is expected that the effects of this potential bias on the results would be minimal.

Another limitation of the current study was the mixed and, at times, unexpected findings related to the validity of the coded measures, particularly the concurrent measure of parent reported social engagement. If shared positive affect and its component behaviors, as defined and coded in the present study, are to be useful measures in the study of infant development and early screening for autism, it is important that empirical evidence support the theoretical link to other important areas such as social engagement, social communication, emotional regulation and temperament, joint attention, and theory of mind. Future research should continue to examine the validity of these shared positive affect behaviors in relation to a variety of measures (e.g., parent report as well as direct standardized observation) across development (i.e., precursor skills, concurrent measures, developmental sequelae).

Furthermore, the current study examined social-affective communication behaviors across the entire STAT session. Previous research has shown that the interactive context (e.g., nature of the assessment or play item, level of adult-provided structure) can influence the social affective behaviors of individuals with autism (Bieberich & Morgan, 1998; Joseph & Tager-Flusberg, 1997; McMahon, 2006). Based on findings from my Master's thesis work (McMahon, 2006), shared positive affect behaviors in a sample of children with autism and typically developing controls were found to be relatively higher during more structured joint attention items (turn-taking and imitation STAT items) than less structured joint attention items (doll play or bag of toys STAT items) or instrumental requesting items (requesting food or bubbles STAT items). It is possible that the group differences found on shared positive affect between Sibs-ASD and Sibs-TD in the current study would vary across the contexts within the STAT. For example, Sibs-TD might show more shared positive affect than Sibs-ASD during joint attention items but not during requesting items, when smiling might be expected to be less frequent for both groups.

Another factor in the interactive context that was not directly assessed in the current study was the presence of additional adults other than the primary examiner in the assessment room. Other adults often included parents or other research staff. The presence of additional adults was not standardized across participants. Therefore, any social-affective or social-communicative behaviors that were directed to adults other than the primary examiner were not considered in the current study. However, this variable could have influenced the study's results. For example, if a particular child tended to be quite shy with the primary examiner, but directed frequent shared positive affect to the parent, those behaviors would not have been captured in the current study. In addition, that particular child's behavior may look very different depending on the presence or absence of the parent in the room. The presence of the parent in the room may itself be an important variable to consider, as parents were often called into the room during the current study to soothe children that were particularly shy, anxious, or distressed. Considering the interactive context and the presence or absence of a parent (as well as behaviors directed to the parent if present) would be a worthwhile next step to examine in further extending and clarifying the results of the current study.

Future research should and will continue to aim toward even younger infants, focusing on development in the first year of life. Positive affect sharing during dyadic interactions is an area that is under-investigated in the field of autism research given that children are often not diagnosed until later in their preschool-aged years. However, the population of at-risk Sibs-ASD provide a particularly promising opportunity to learn more about the trajectory of social-emotional development in autism or the broader autism phenotype. The results of the current study should be extended to younger ages and examined longitudinally so that the developmental trajectories of shared positive affect and related behaviors may be examined from the time when they are beginning to emerge with the first social smile to when they are well-established in early childhood. A productive line of future research would be to develop standardized observation contexts to use with infants in the first year of life and utilize standardized coding systems (e.g., computer software designed to read eye gaze direction and facial expressions) to capture emerging shared positive affect behaviors during face-to-face dyadic interactions and establish normative data on shared positive affect behaviors. Directly relating these behaviors to brain function and development (e.g., through EEG and fMRI) will also be important avenues for further research.

The primary research question driving the interest in this study was to examine shared positive affect as a unique behavioral construct in a sample of younger at-risk siblings of children with autism to determine what, if any, role positive affect sharing may have in early screening and diagnosis of autism. It is unlikely that positive affect sharing alone will be sufficient to provide a one-item screen for autism risk. Other areas, such as atypical motor development and sensory sensitivities in young infants have also been shown to be related to ASD (Baranek, 1999). However, it is possible that adding measures of positive affect sharing to well-established screening tools may improve the sensitivity and specificity of those tools, particularly for children under 12 months of age. The results of the current study support shared positive affect as a promising behavioral risk marker to use in the early screening and diagnosis of autism spectrum disorders. Future research should examine how the application of this behavioral measure might enhance the sensitivity, specificity, and predictive validity of screening measures used with young children, such as the Screening Tool of Autism in Two-Year-Olds (STAT).

APPENDIX

Detection of Autism by Infant Sociability Interview (*DAISI*)
Wimpory, Hobson, Williams, & Nash, 2000

DAISI Item	Dyadic or Triadic Item?
1. Did s/he have difficulties in the frequency and/or intensity of eye-contact?	Dyadic
2. Would s/he look both to where s/he was pointing and to you? (Referential eye-contact)	Triadic
3. Would s/he greet you?	Dyadic
4. Could you stop him/her crying by picking him/her up?	_
5. Could you stop him/her crying by just talking to him/her?	_
6. Could you amuse him/her without toys (if say, you were together on a bus or in a doctor's waiting room where no toys were available)?	Dyadic
7. Did s/he enjoy lap games?, e.g.,"Peek-a-boo"	Dyadic
8. Did s/he actively participate [in lap games]?	_
9. Would s/he be happy for you to join in his/her play with toys or would s/he regard that as an intrusion and prefer to play alone?	Dyadic
10. Would s/he offer and give objects?	Triadic
11. Would s/he show you things?	Triadic
12. Would s/he use pointing communicatively?	Triadic
13. Could s/he follow your pointing gestures? Where would s/he look . . . towards your finger or to where you were pointing?	Triadic
14. Would s/he spontaneously and appropriately wave goodbye?	Dyadic
15. Would s/he spontaneously lift her arms to be picked up?	Dyadic
16. Would s/he tease you?	_
17. Did s/he take turns before s/he could talk, e.g., with babbled noises?	Dyadic
18. Would s/he appear to direct anger and/or distress with apparent communicative intent?	Dyadic
19. Were his/her baby noises communicative?	Dyadic

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