Orientation and affect directed towards social and nonsocial targets in infant siblings of children with Autistic Spectrum Disorder (ASD).

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Abstract

This study contributes to a growing body of work aimed at documenting and defining behavioral markers associated with early autism spectrum disorder (ASD) and its broader phenotype. A total of 19 infants (sib-ASD), who have a sibling diagnosed with ASD were seen at 6.5 months, and 23 infants were seen at 9 months. Sib-ASD infants were matched in age and gender with low-risk infants (sib-TD), who have a typically developing sibling. Infants were simultaneously presented two stimuli, a person's face (the social stimulus) and a brightly colored toy (the nonsocial stimulus). We found there were no significant differences between at-risk infants and low-risk infants in their responsiveness to and disengagement from the stimuli. However, a significant group difference did appear in the 9 month infants' time smiling. Sib-TD infants spent more time smiling at the nonsocial as compared to the social stimulus relative to the sib-ASD infants, who showed no preference in time smiling for one stimulus over the other. This unexpected finding contradicted our initial predictions that sib-TD infants would prefer the social stimulus and thus spend more time smiling at the experimenter's face, while sib-ASD infants would prefer the nonsocial stimulus, and thus spend more time smiling at the toy.

Introduction

Autism is the most common of disorders categorized under the broad term Autism Spectrum Disorder (ASD). The neurological disorders included under this term are autism, Asperger's Disorder, Rett's Disorder, Childhood Disintegrative Disorder, and atypical autism, also known as PDD Not Otherwise Specified or PDD-NOS (Stone, 2006). These disorders are characterized by varying degrees of impairment in social interactions, communication skills, and restricted, repetitive, patterns of behavior (Osterling et al., 2002). Autism generally affects 10 of every 10,000 individuals, Asperger's Syndrome has a prevalence estimate of 2.4 per every 10,000, and PDD-NOS generally affects 15 per every 10,000 individuals (as cited by Freitag, 2007). Additionally, autism is 3 times more likely to affect males than females (Smalley, Asarnow, & Spence, 1988).

Autism is a neurological disorder which typically affects an individual's abilities to communicate and interact with others. By 3 years of age, an individual with autism displays noticeable deficits in his or her abilities to produce speech and to interact socially. These symptoms may be noticeable prior to the third year of life, but they are not typically severe enough for autism to be formally diagnosed until about 3-4 years of age. Many parents of children with autism, however, have reported that their children showed significant deficits before the age of 1 year (Baranek, 1999; Werner, Dawson, Osterling, & Dinno, 2000). Specifically, parents describe their children as displaying many of the following behavioral deficits: extreme temperamental behavior ranging from excessive irritability to discernible passivity, poor eye contact, a lack of interactive play, and a lack of response to parental attempts at interaction (Adrien et al., 1992; Bernabei et al., 1998; Osterling and Dawson, 1994; Maestro et al., 1999; Mars et al., 1998; Zakian et al., 2000, as reviewed by Zwaigenbaum et al., 2005). This information provides reason to believe that earlier diagnosis, specifically before 1 year of age, is possible. Earlier detection is optimal for it allows earlier behavioral intervention. Early intervention can have considerable positive effects on long term behavioral development (Osterling, Dawson, & Munson, 2002).

In an attempt to understand how autism develops, researchers have investigated the early social and social-communicative deficits displayed by individuals with autism before 3 years of age. Researchers have used the method of analyzing pre-diagnosis home videos in order to examine the social and communicative behavior displayed by infants aged 9- 12 months who are later diagnosed with autism (Baranek, 1999; Osterling & Dawson, 1994; Osterling et al., 2002; Werner et al., 2000). The most common finding is that children who developed autism showed deficits and delays in their ability to respond to attention getting strategies used by parents. Infants who developed autism were less likely to respond when their names were called and required more name prompts to get their attention (Baranek, 1999; Osterling & Dawson, 1994; Werner et al., 2000). In the video-review analysis conducted by Werner, Dawson, Osterling, and Dinno (2000), the sample of 12 infants who went on to develop autism successfully oriented to their name being called only 37% of the time, as compared to 75% of the time for the sample of 15 typically developing infants. However, this data pertains only to infants with early-developing autism; that is, parents report that they noticed deficits or delays in the child's behavior prior to the diagnosis at or around 3 years of age. Those who developed autism later, 3 additional participants, tended not to deviate from typically developing infants in their early social capabilities (Baranek, 1999; Werner et al., 2000).

In order to make sure these supposed autism symptoms are syndrome- specific, some studies have added in a second comparison group of infants with developmental delays (Baranek, 1999; Osterling et al., 2002). Autism is often coupled with mental retardation. According to Smalley, Asarnow, and Spence (1988), 66 to 75% of individuals with autism have IQ scores equal to or less than 70 (as reported by Osterling et al., 2002). Baranek (1999) reviewed video tapes for the different social patterns and sensory motor- function capabilities displayed by infants who developed autism, typically developing infants, and infants with Down syndrome. Baranek (1999) found that not only did the infants who went on to develop autism respond less to social stimuli than the typically developing group, but they also responded significantly less than infants with Down's syndrome. Osterling, Dawson, and Munson (2002) compared video tapes of infants who were later diagnosed with autism and mental retardation, to infants with autism only and to typically developing infants. They found that as infants, the ASD+MR group demonstrated significantly less responsiveness to their name, or responsiveness did eventually occur but required excessive name prompts. Also, infants who developed autism looked at others much less frequently than infants with mental retardation only. The authors suggest that these social behavior deficits may be associated specifically with autism.

Several video review studies have also reported that infants who developed autism showed differences in initiating looks to other people, smiling at others, and coordinating attention between people and objects (Osterling & Dawson, 1994; Osterling et al., 2002; Werner et al., 2000). Werner, Dawson, Osterling, and Dinno (2000) found that the typically developing infants looked at others while smiling an average of 4.3% of the time, while the infants who developed autism looked at others while smiling only 1.5% of the time. Baranek (1999), however, did not find that looking at people was a significant indicator of autism. Also, infants who developed autism were less likely to look at objects held by another individual or to show an object to another individual (Baranek, 1999; Osterling & Dawson, 1994; Osterling et al., 2002). Finally, research shows that infants who developed autism were less likely to use communicative gestures (Osterling & Dawson, 1994; Osterling et al., 2002). Researchers have also looked at behaviors that serve as the best predictors of later autism. Osterling and Dawson (1994) found that failing to look at another person's face is the single best predictor of a child's later diagnosis of autism. When accompanied by other behaviors such as failing to point, failing to show an object to another, and failing to orient to one's name, failing to look at another person's face correctly classified 91% of the participants. Baranek (1999), on the other hand, found that the best behavioral predictors of autism are mouthing of objects, social touch aversions, lack of orientation to either others or to objects, and an increased number of name prompts prior to orientation. This classification analysis correctly positively predicted 93.75% of the cases. Werner, Dawson, Osterling, and Dinno (2000) found that the single best predictor of later developing autism is failure to orient to name. This behavior alone correctly classified 78% cases in this study. Classification rate did not significantly improve when other social behaviors were assessed.

These retrospective video analyses, however, have several limitations. Home videos may be a narrow representation of infants' behavior as parents choose the situations to videotape by turning the camera off when they do not think their child is doing anything interesting. These moments that are not caught on videotape may contain behaviors that could be crucial predictors of later autism. Additionally, eye contact and infants' facial expressions are difficult to judge because of the nature of the videos; coders cannot see everyone simultaneously and at all times. Moreover, the videotapes had to display not only the infant with autism, but other individuals as well, since the information coded relied on social interaction and communicative-behavioral tendencies. The individuals on the videotapes have histories of interacting with the infants, which may influence their behaviors and responses toward the infant.

Another limitation of the current literature lies in the sample size and selection. Sample size was often small due to the fact that researchers tended to have a difficult time locating families of individuals with autism, who were both willing to participate in the study, and who had videotapes of their child with autism before the age of 12 months. Thus, samples may not be representative of all behavior. There is also concern that these videotape reviews may not correctly represent the population of autistic children. Much variability exists within the population of individuals with autism, which leads to diverse samples and makes sample selection difficult. Furthermore, videotapes were more likely to be made of higher-functioning individuals. For example, in the video tape review conducted by Osterling and Dawson (1994), the autistic sample was found to be higher functioning than the general population of individuals with autism.

More recent research is based on a different methodology: prospective infant-sibling assessment. Researchers conduct longitudinal studies, in which infants with siblings diagnosed with ASD are compared to infants with no family risk for ASD (Yirmiya et al., 2006; Zwaigenbaum et al., 2005). Autism is a genetic disorder; it has a monozygotic concordance rate of 64%, a conservative dyzygotic concordance rate of about 4.5%, and a more liberal dyzygotic concordance estimate of 8.6% (Veenstra- VanderWeele & Cook, 2003). Since siblings share 50% of their genes like fraternal twins, siblings of individuals with autism also have a 4.5- 8.6% chance of developing the disorder (Veenstra- VanderWeele & Cook, 2003). By a conservative estimate, autism has a recurrence risk of about 3- 5% in families (Smalley et al., 1988; Stone, 2006; VanDerWeele & Cook, 2003). A more liberal estimate is a 10% recurrence risk

(Zwaigenbaum et al., 2005). An average individual of the general population has approximately 0.2% chance of developing autism; that is, about 1/500 individuals will develop the disorder. Thus, with a base occurrence rate of .002, siblings of individuals already diagnosed with autism are at a 20- fold increased risk for developing autism, as compared to individuals who do not have siblings diagnosed with autism. Although not all of these siblings in the ASD group go on to develop autism, infant-sib paradigms have found that an additional 17% of sib-ASD infants exhibit social communication delays as the broader phenotype of autism (Stone, 2006; Yirmiya, 2006).

An advantage of the infant-sibling paradigm is that the social contexts which the infants' behavior is examined can be systematically controlled. Each child is observed in a one-on-one interaction with an experimenter. This interaction follows a detailed protocol in a structured laboratory setting. By having participants complete specific laboratory tasks measuring their capabilities, opportunities for social interaction are standardized. This, in turn, allows for behavioral tendencies, or lack thereof, to be coded in a more uniform and organized manner.

Zwaigenbaum and his colleagues' (2005) prospective infant-sib study followed 7 infants who were correctly diagnosed with autism by 24 months of age. The infants in the early autism group, when rated at 12 months of age, displayed more pre-selected behavioral risk markers during assessment interaction. The markers included atypically rated eye contact, visual tracking deficits, delays and deficits in responding to name, lack of imitation, lack of social smiling during object play, low reactivity, low social interest, and repetitive sensory-oriented behaviors. Another important finding yielded by the Zwaigenbaum (2005) study is that infants in the early autism group had a more difficult time disengaging visual attention. Infants were presented with a centrally located brightly colored stimulus. Once the child was engaged on the central fixation stimulus, a second stimulus appeared on the right or left side. Infants with early autism were much more likely to get stuck on the centrally located stimulus and never look at the new stimulus that appeared in their periphery. However, when the infants were seen at 6 months of age, these markers, including disengagement, did not distinguish the early-ASD group.

This paradigm must be refined to characterize the behavioral and communicative deficits of infants less than 12 months of age because much advancement in social abilities occurs during this time. Striano and Bertin (2005) investigated infants' ability to coordinate affect with joint attention. They found that many infants are capable of coordinating visual attention to an object with mothers and strangers by 5-7 months of age. Specifically, by 7 months of age, infants were more likely to coordinate attention with strangers than mothers.

Typically, infants make further advances in their social, emotional, and communicative behaviors around 8-10 months of age. By this age, infants routinely use eye contact, orient to others' faces, and engage in social smiling (as reported by Werner et al., 2000). Striano and Bertin (2005) found that by 9 months of age, both joint engagement looks alone and joint engagement looks with smiles were significantly higher with strangers than with mothers. This ability to coordinate attention with another individual provides a necessary foundation for later developing social referencing, language learning, and imitative learning (as reported by Striano & Bertin, 2005). More complex behaviors including joint attention, initiating coordinated attention, response to the call of their name, gestural communication, and communicative vocalization become apparent by 1 year of age (Osterling et al., 2002; Striano & Bertin, 2005).

In order to better understand autism before the age of 1 year, researchers must continue to refine this new methodology of prospective assessment of infants. Both direct observation of the infant and longitudinal evaluation by means of post-hoc systematic video analysis are necessary.

Thus, we propose to examine the risk markers highlighted in the video-research of sib-ASD infants as compared to sib-TD infants in a laboratory setting.

This study aims to quantify the specific behavioral markers that were both commonly exhibited in the video studies and predictive of later autism. We also examined infants' ability to disengage from a stimulus, modeled after the study conducted by Zwaigenbaum and colleagues (2005). In an attempt to help define autism-specific impairments, we will compare in a fixed laboratory setting, sib-ASD and sib-TD infants on their orientation and affect to social versus nonsocial objects. Specifically, we will compare orientation time to social relative to nonsocial calls; preferences, or lack thereof, for looking at social or nonsocial stimuli; and tendencies to smile socially to social relative to nonsocial stimuli. Finally, we will compare infants' time to disengage from a stimulus, regardless of type. We will do so by examining infants' response times to the calls of the stimuli. Based on the findings of previous research, we hypothesize that infants in the sib-ASD group, compared with those in the sib-TD group, will take longer to orient to a person and to shift gaze between stimuli; will look less at a person than at a toy; and will smile less frequently at a person than at a toy.

Method

Participants

Each infant in the SIB-TD group was matched with an infant from the SIB-ASD group based on age (+/- 10 days) and gender. Due to time constraints, the last matched pair of the study was matched in gender, but differed by 17 days in age. A total of 38 infants were seen at 6.5 months; each of 19 infants in the SIB-TD group was matched with one of 19 infants in the SIB-ASD group. Of the 38 infants seen at 6 months, 3 in the SIB-TD group and 2 in the SIB-ASD group did not go on to be tested at 9 months.

A total of 46 infants were seen at 9 months; 23 infants in the SIB-TD group and 23 infants in the SIB-ASD group. Of these 46 infants, 7 in the SIB-TD group and 6 in the SIB-ASD group were seen only at 9 months.

In addition, we had a total of 5 sib-TD infants who came in for a visit, but were not used in this matched-pair analysis. On occasion, a sib-TD infant was run in anticipation of being contacted by a suitable sib-ASD match who never materialized. Due to cancellations and rescheduling for the second visit, infants' ages sometimes no longer fell within +/- 10 days of their matched counterpart in the sib-ASD group. In order to maintain matching, the infants in the sib-TD group were re-matched with a new 9 month infant of the same age and gender. Each participant was assigned an identification number so that personal information and risk status were unknown to blind experimenters and coders.

Selection Criteria

SIB-ASD Group

The sib-ASD infants were between the ages of 6 months 10 days and 7 months 7 days. The mean age was 6 months 20 days with a standard deviation of 6.83 days. For the 9 month group, infants were between the ages of 8 months 16 days and 9 months 27 days. The mean age was 9 months 7 days with a standard deviation of 10.65 days. All of these infants have: 1) an older sibling diagnosed with autism, Asperger's syndrome, or PDD-NOS; 2) the absence of severe sensory or motor impairments; and 3) absence of identified metabolic genetic or progressive neurological disorders. Participants were volunteers who contacted the lab after hearing or seeing an advertisement for the study.

SIB-TD Group

Infants were between the ages of 6 months 11 days and 7 months 7 days. The mean age was 6 months 20 days with a standard deviation of 6.62 days. For the 9 month group, infants were between the ages of 8 months 19 days and 9 months 20 days. The mean age was 9 months 6 days with a standard deviation of 8.15 days. All of these infants have 1) an older sibling of typical development; 2) no family history of autism or mental retardation in first degree relatives; 3) no severe sensory or motor impairments; and 4) no identified metabolic, genetic, or progressive neurological disorders. Participants were volunteers who contacted the lab after hearing or seeing an advertisement for the study.

Apparatus

Infants were seated in a high chair (or on their parent's lap if they were not comfortable in the chair) facing a black partition, which measured 30 inches in width.

Figure 1. Apparatus

The stimuli included both an experimenter (social stimulus) and a toy (non-social stimulus). Throughout the course of this study 5 different individuals served as examiners, 4 females and 1 male. The toy was held by another experimenter, but the face and body of the experimenter were hidden by the apparatus so that only the toy was visible to the infant. The toy presented was either a large plastic Fisher Price© fishbowl, a large bowl filled with plastic fish, decorated with brightly colored plastic balls hanging down the side; or a large rattle (shown below in Figure 2), consisting of bright colors and decorated with silver reflective ribbon.

Figure 2. Apparatus and stimuli

Two cameras were set up to record the experiment. The first camera monitored the baby's face. The second camera monitored the experimenters, zoomed out enough to display the entire partition and the stimuli that appear on either side.

Procedure

The infants were presented the social and nonsocial stimuli simultaneously in a procedure called the paired comparison. The paired comparison task lasted 30 seconds. At the beginning of the trial, an experimenter behind the apparatus stepped on a pedal to illuminate a light in the center of the apparatus. The light was illuminated for 3 seconds to ensure the baby was looking in a neutral location before the stimuli appeared. As soon as the light went out, both stimuli (social; the experimenter's face and nonsocial; the toy) appeared simultaneously. One stimulus appeared on the left side of the apparatus and the other stimulus appeared on the right side of the apparatus. The left- right position of the two stimuli (social and nonsocial) was counterbalanced and remained the same within matched pairs of subjects.

After the stimuli was visible for a count of five seconds, one of the stimuli “called” to the infant. The call order (which stimulus called first) was counterbalance to eliminate biases, but was to remain standardized between the two matched infants. When the social stimulus “called” the experimenter delivered the phrase, “Hi, ______ (baby’s name)!,” with a smile. When the nonsocial stimulus “called,” the toy was shaken to elicit a rattling noise. If the participant did not look at the stimulus after the call, the call was repeated until the participant looked. Five seconds after the infant looked, the other stimulus called. The second stimulus would also continue to call if the infant did not look after the first call. After another 20 seconds, both stimuli retreated back behind the apparatus.

We aimed to keep the call order, stimuli location, and nonsocial stimuli exemplar presented constant for matched pairs. For 95% of the pairs, the order in which the stimuli called to the child remained constant across pairs and for 88% of the pairs, the left-right orientation of the stimuli was standardized. For 100% of the matched pairs, the toy presented (the rattle or the fishbowl) was the same for the sib-ASD baby and its paired sib-TD baby. We attempted to keep the social stimuli, the experimenter’s face, constant as well; however, due to experimenter availability and baby scheduling, control of this variable was not always feasible. For 64% of the matched pairs, the experimenter presented remained constant between the two infants in a pair.

Coding

The videotapes were transferred to CD, which were then viewed using the software Procoder©, which allows frame by frame coding for critical events. One primary coder and an assistant, both blind to the infants' risk group, coded each videotape. The assistant coder set up the code files for the primary coder by marking the start and end times of the trial. This allowed the primary coder to be blind to the stimuli locations. The trial start time was marked as the moment immediately before the two stimuli come into view. The end time was generally marked after exactly 30 seconds; but in some cases was extended as necessary to accommodate both calls plus a 5 second response-window after the second call. In some instances, the infant did not respond immediately to either the first or second call and the trial had to be extended to accommodate the required additional call prompts. In such cases, the coded trial lasted exactly 5 seconds after the infant responded to the second call.

The primary coder marked the Procoder© files set up by the assistant. This coder marked the beginning and marked the end of each single target location look for the 30 second trial. If the baby looked to the right, the beginning time to be marked was the 1/300 second the baby's eyes were centered on the right target. As soon as the baby's eyes shifted from that location, the look was over and the end time was marked. If the baby looked to the right, glanced away, and looked back at the stimulus, this was coded as 2 different looks to the right. The same procedure was repeated for looks to the left.

After coding all the times for looks, the coder marked initiating smiling time. Initiating smiles refer to smiles that began while looking at one of the stimuli. If the infant was looking somewhere other than the stimuli, began smiling, and then shifted gaze to one of the stimuli, this smile was not coded. A new initiating smile was not coded unless the baby ceased smiling first and then smiled again, or if the baby's smile enlarged as a result of a positive reaction to one of the stimuli. The procedure for marking the beginning and end of a smile was the same as looking time coding. The smiles coded were judged as communicative; that is, babies were smiling intentionally to interact with the experimenter or in enjoyment of the toy. The coder marked the beginning of the smile as the moment when the lips began to curl and the cheeks became defined. The end of the smile was marked as the 1/300 second the baby's face loses the interactive smile. The smiles all fell within the timeframe of a look to a single stimulus. Thus, as soon as the baby broke eye contact with the left or right stimulus, both the look time and the smile time ended. An instance in which the infant was smiling and shifted gaze from social to nonsocial, no smile time was recorded to the nonsocial; an instance in which the infant was smiling at the nonsocial and shifted gaze to the social while still smiling, no social smile time was recorded. Smile times were coded as beginning and ending only during the look in which the smile was initiated.

After smiling and looking time was coded, the coder marked the time of the first and second calls. At this time, the coder became unblind to the left- right orientation of the stimulus. The coder watched the view of the experimenters and marked the very beginning of the call, either as soon as the toy began to shake or the mouth of the experimenter began to move.

Table 1. Coded Measures and Corresponding Definitions

Measure	Definition
Smiles initiated to the social	Number of smiles initiated while looking at the experimenter
Smiles initiated to the nonsocial	Number of smiles initiated while looking at the toy
Looking time to the social	Time (1/300 seconds) spent looking at the experimenter
Looking time to the nonsocial	Time (1/300 seconds) spent looking at the toy
Number of looks to the social	Number of looks to the experimenter
Number of looks to the nonsocial	Number of looks to the toy
Latency to orient to the social	Time (1/300 seconds) to look at the experimenter after he/she calls
Latency to orient to the nonsocial	Time (1/300 seconds) to look at the toy after it calls
Look inconsistencies to the social	Standard deviation of looks (1/300 seconds) to the experimenter
Look inconsistencies to the nonsocial	Standard deviation of looks (1/300 seconds) to the toy
Smile time to the social	Time (1/300 seconds) spent smiling at the experimenter
Smile time to the nonsocial	Time (1/300 seconds) spent smiling at the toy
Time to disengage from the social	Time (1/300 seconds) to look away from the experimenter after it calls
Time to disengage from the nonsocial	Time (1/300 seconds) to look away from the toy after it calls

Reliability

A second coder rated 10% of the trials to ensure interrater reliability. A total of 84 trials were coded at 6.5 and 9 months. The second coder recoded 8 trials. Coders were in agreement as to whether or not a look was occurring (k= 0.82) and whether or not a smile was occurring (k= 0.83).

Methods of Data Analysis

Main group comparisons were relative responsiveness to social stimuli over nonsocial stimuli. Responsiveness was investigated as: total looking time or variability of looks; total number of looks; total time smiling; total number of smiles initiated; and latency to orient to a call. We also compared latency to disengage from the first stimuli. We first looked at the data distribution to decide whether to use parametric or nonparametric statistics. Using the statistical program SPSS©, variables with normally distributed data were explored through paired t-tests; variables with abnormally distributed data were explored through the Wilcoxon Matched- Pairs Signed Ranks Test.

The stimuli specific responsiveness variables were: total number of looks to each social stimuli, the total amount of time spent looking at each stimuli, the standard deviation of looking time to each stimuli, the amount of time taken to react to the call of each stimuli, the total number of initiating smiles to each stimuli, and the total time spent smiling at each of the stimuli. To calculate the relative social responsiveness we used the equation social- nonsocial to find the difference in reactions to each stimulus. The final sns variables are listed in Tables 2 and 3 below. For each infant we subtracted the number of looks to the nonsocial from the number of looks to the social stimulus (snsNL); the total time spent looking at the nonsocial stimulus from the total time spent looking at the social stimulus (snsLT); the inconsistency (standard deviation) of social looks and nonsocial looks (snsIL); time to orient to the call of the nonsocial stimulus from time to orient to the call of the social stimulus (snsRT); and the number of smiles initiated at the nonsocial stimulus from the number of smiles initiated while looking at to the social stimulus (snsISM). The final calculation for smiling times is the total time spent smiling at the nonsocial stimulus from the total time spent smiling at the social stimulus (snsSM). For each infant, we also looked at the total time to disengage from the call of the first stimulus (Time_Dis). The stimulus to call first (social or nonsocial) was the same for matched pairs, and was determined by trial order.

We ran the paired t-tests and the Wilcoxon Matched- Pairs Signed Ranks Tests with and without outliers for each variable. Outlying data was defined as that which was more than 3 standard deviations above or below the mean, using the equation (3x standard deviation) + /- mean. Based on this criteria, for the 6.5 month infants, the outliers were: 1 infant in the sib-TD group and 1 infant in the sib-ASD group for snsRT (social minus nonsocial latency to orient); 1 infant in the sib-TD group and 1 infant in the sib-ASD group for the Time_Dis (time to disengage from the stimulus which called first); and 2 infants in the sib-TD group and 2 infants in the sib-ASD group for snsSM (social minus nonsocial time smiling). For the 9 month infants, the outliers were: 2 infants in the sib-TD group and 2 infants in the sib-ASD group for the snsRT data (social minus nonsocial latency to orient); 1 infant in the sib-TD group and 1 infant in the sib-ASD group for the Time_Dis data (time to disengage from the stimulus which called first); and 1 infant in the sib-TD group and 1 infant in the sib-ASD group for the snsSM data (social minus nonsocial time smiling).

Results

There were no significant differences between groups in age for the 6.5 month infants, t (2, 18) = -0.20, p>.05 or for the 9 month infants, t (2, 22) = -0.46, p>.05.

For our primary analysis, we used the paired t-test or the Wilcoxon Matched- Pairs Signed Ranks Test to compare means based on the s-ns (social minus nonsocial, Tables 2 and 3) calculations; thus, all comparisons except time to disengage compare the groups on their reaction to the social stimulus relative to the nonsocial stimulus. The following tables reflect the data excluding outliers.

Table 2. Performance by 6.5 Month Sib-TD and Sib-ASD Infants

			SIB- TD		SIB-ASD		
6.5 months		n	mean	SD	mean	SD	t-value/ z-score
S-NS smiles initiated	snsISM	19	0.16	0.90	0.42	1.22	-0.70
S-NS looking time	snsLT	19	-3.27	10.70	-0.42	11.09	-0.96
S-NS number of looks	snsNL	19	0.42	1.39	0.16	1.43	0.57
S-NS latency to orient	snsRT	18	1.38	3.72	0.42	2.07	1.12
S-NS look inconsistencies	snsIL	19	-1.09	3.62	-0.32	3.14	-0.91
S-NS smile time	snsSM	17	-0.04	1.42	0.72	1.25	-0.03^
Time to disengage from 1st Stimulus	TimDis	18	6.22	3.65	6.01	2.57	0.18

^ z-score reported by Wilcoxon Matched- Pairs Signed Ranks Test.

Table 3. Performance by 9 Month Sib-TD and Sib-ASD Infants

			SIB- TD		SIB-ASD		
9 months		n	mean	SD	mean	SD	t-value/ z-score
S-NS smiles initiated	snsISM	23	0.43	1.08	0.30	0.82	-0.41
S-NS looking time	snsLT	23	-9.13	10.84	-8.78	8.60	-0.11
S-NS number of looks	snsNL	23	-0.57	1.95	-0.04	1.55	-0.97
S-NS latency to orient	snsRT	21	4.20	3.33	3	0.99	-1.42
S-NS look inconsistencies	snsIL	23	-1.85	2.68	-1.86	2.27	-0.03
S-NS smile time	snsSM	22	-1.68	3.54	0.37	2.66	-2.15^*
Time to disengage from 1st Stimulus	TimDis	22	4.20	3.33	3.96	2.35	0.30

^ z-score reported by Wilcoxon Matched- Pairs Signed Ranks Test.
* p< 0.05.

Six of the seven variables were found to demonstrate no group differences when run with and without the outliers. At 6.5 and 9 months, the risk groups (sib-TD and sib-ASD infants) showed no differences in the total amount of time they spent looking at the social relative to the non-social stimuli; no differences in the relative number of looks to the social stimuli; no differences in the relative reaction time to the calls of the social stimuli; no differences in the relative number of smiles initiated to the social stimuli; and no differences in the time to disengage; that is, the amount of time between the call of the first stimulus and when the infant ceased looking at it.

A group difference, however, did appear in the 9- month infants' relative amount of smiling time at the social and nonsocial stimuli. The infants in the sib-TD group spent more time smiling at the nonsocial stimulus than the infants in the sib-ASD group.

Table 4. Smiling Performance of 9 Month Sib-TD Group.

	9 months	Sib-TD	(n = 22)	
	S Smile Time (s)	NS Smile Time (s)	S # of Smiles	NS # of Smiles
Mean	1.50	3.20	0.82	0.41
SD	2.11	4.84	0.96	0.91
Max	6.50	16.80	3	3
Min	0	0	0	0

Table 5. Smiling Performance of 9 Month Sib-ASD Group.

	9 months	Sib-ASD	(n = 22)	
	S Smile Time (s)	NS Smile Time (s)	S In. Smiles	NS In Smiles
Mean	2.20	1.80	0.59	0.32
SD	3.99	2.83	0.91	0.72
Max	12.90	8.70	3	3
Min	0	0	0	0

Figure 3.

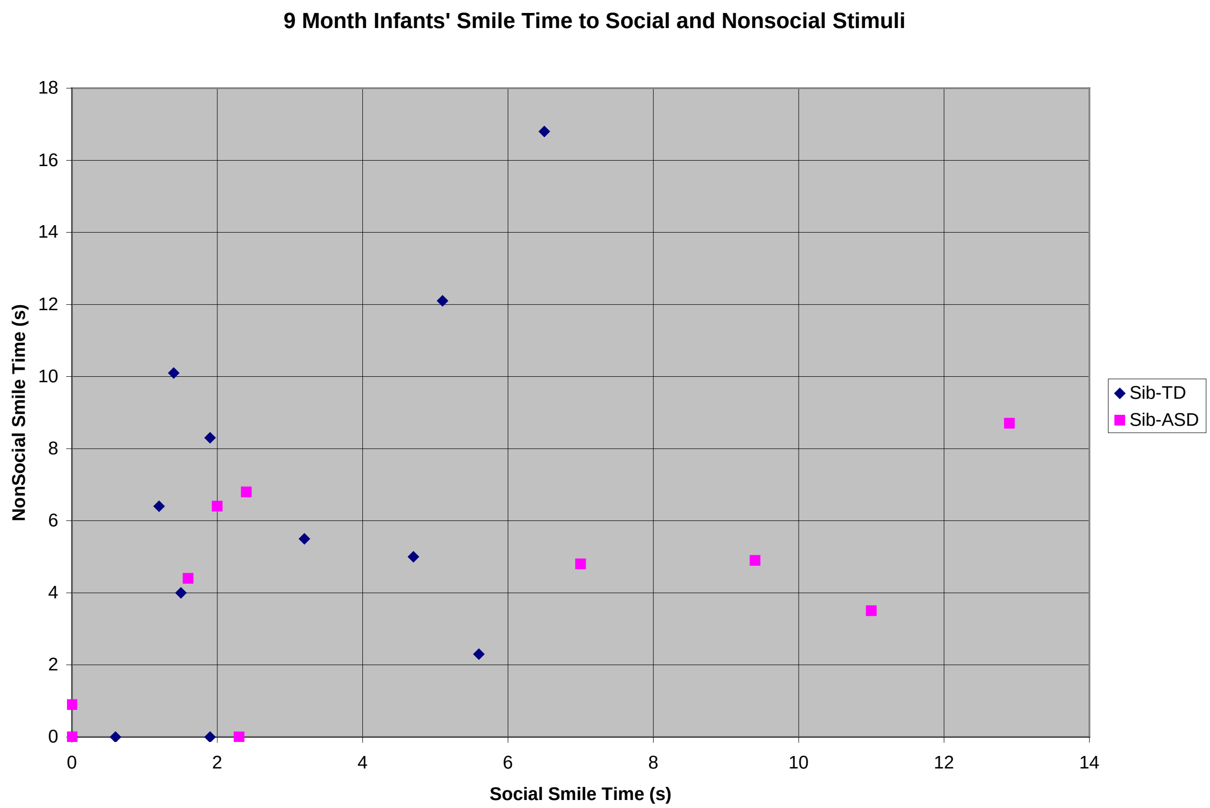

Figure 3 depicts the 9 month infants' distribution of smiling time at the social relative to the nonsocial stimulus. At 9 months, 11 of 22 infants in the sib-TD group and 13 of 22 infants in the sib-ASD group did not spend any time smiling at either the social stimulus or the nonsocial stimulus. Thus, roughly 50% of the participants had 0 s for smile time. Of those that smiled, 70% of the sib-TD infants spent more time smiling at the nonsocial stimulus. The sib-ASD infants are split in half; 50% smiled longer at the social stimulus and 50% smiled longer at the nonsocial stimulus. In the sib-ASD group, the largest social and nonsocial differences favored the social stimulus. These results contradict our initial predictions that infants in the sib-ASD group would have an overall preference for the nonsocial stimulus over the social stimulus, and that the sib-TD group would be more inclined to engage in social interaction by smiling longer at the social stimulus than the sib-ASD group.

Re-Analysis with Outliers Included

The group comparison listed in Tables 2 and 3 were re-run with data sets including the outliers (described above), which were removed from the original analysis. The 9- month s-ns smiling time group difference from the original analysis was no longer significant, but was found instead at 6.5 months. For the 6.5 month infants, this difference was significant only when the data included the outliers, $z\ (2, 18) = -2.30$, $p< .05$; for the 9 month infants, this difference was significant only when the data excluded the outliers (see Table 3). At both ages when the significant difference in the social minus non-social score was found, the direction was the same.

The two outliers removed from the 6.5 month data were sib-ASD infants who smiled for a particularly long time (+3 SD) at the social stimulus. The inclusion of these 2 participants in the data increased the overall sib-ASD time smiling to the social, thereby increasing the social-nonsocial time smiling. In removing these two outliers, the relative smiling time between risk groups was no longer significant.

Discussion

We compared the social responsiveness and disengagement of attention exhibited by infants at a higher risk for autism, the sib-ASD group, and infants at a lower risk for autism, the sib-TD group. This study examined the variables which were found to exhibit differences between groups in the previous retrospective video studies. Specifically, variables included looking time to people and to objects, smiling time to people and to objects, response to calls of people and objects, and disengagement of attention from both people and objects. This study compared infants' responsiveness to people relative to toys, the time to disengage attention, and the inconsistencies in attention.

No preferential differences on the majority of the responsiveness markers or on the single attention variable were found between the two groups, the sib-ASD and the sib-TD. There are several reasons which may explain our null findings. First, social deficits may not have emerged yet. Zwaigenbaum and his colleagues (2005) conducted an infant-sib paradigm and did not find any statistically significant differences between groups for infants less than 12 months. Additionally, in previous studies, those with late-developing autism tended not to differ from typically developing infants in their early social-communicative skills (Baranek, 1999; Werner et al., 2000). Infants with late-developing autism seem to be on a path toward normal development, until between the ages of 15 to 24 months they begin to show a drastic decline in social and cognitive ability. Thus, in the instance of this study, a portion of the infants in the sib-ASD group may display no early signs of social communicative delays, but such deficits may become apparent later on in development.

Second, biases within the videotapes used in the retrospective video analyses may be causing the differences seen between groups in these studies. Home videos are a narrow representation of infants' behavior; difficulty judging eye contact and infants' facial expressions, and restricted sample size and selection are all limiting factors which may contribute to significant differences between groups. A third reason is that we examined a group of infants *at higher risk* for autism or the broader phenotype of autism (that is, a disruption of the core symptoms of autism, ranging from mild to severe without the diagnosis itself); while retrospective video analyses examine individuals who have already been diagnosed with autistic disorder.

Fourth, responsive and disengagement differences may not be seen in this scenario of social relative to nonsocial; that is, group differences may be tied directly to the social nature of the stimulus without comparison to the nonsocial. However, a group difference was found in the social relative to the nonsocial stimulus in a similar study conducted (Noland et al., under review). Infants who participated in the paired comparison game participated immediately afterwards in another task assessing working memory with the same social and nonsocial stimuli. In this working memory task, infants played peek-a-boo games with a person and a toy. The person or the toy would emerge from behind an apparatus in one of three positions. Infants were tested on their ability to remember the location of the social or nonsocial targets by looks, after a distraction, to the location of its immediately prior appearance. For this task, a significant difference between groups was found using the social-nonsocial equation; sib-ASD infants had better working memory for nonsocial targets than sib-TD infants. This suggests that the results of the paired comparison task may be true null findings.

It is possible that a true difference occurred that we were unable to observe. The highly constrained testing situation limits our ability in contrasting the current null findings with previous findings from more naturalistic settings. Specifically, the unnatural social interaction of this test may not be sensitive enough to illuminate differences between the two groups. Real differences in infants' responsiveness to the two stimuli may have been possible in a more natural situation. A second limitation to the conclusion of null results is that variability existed in the actual procedure of the experiment. For example, inconsistency in the experimenter who served as the social stimulus for each individual of the matched pairs may have masked a true difference. Additionally, it would have been ideal to control for the gender of the experimenter presented as well, but such standardization was not feasible in the capacity of this study.

We did observe a group difference for the 9 month infants' smile time to the social stimulus relative to the nonsocial stimulus. This group difference, however, contrasted our initial predictions. The sib-TD group spent less time smiling at the examiner than at the toy. These infants may be smiling less at the social stimulus relative to the sib-ASD group because they realize the unnaturalness and robotic nature of the experimenter's interaction. One explanation may be that the natural social progression begins with face-to-face interaction and then with development, social interaction extends to objects. Before 6 months of age, infants are much less likely to smile at an object on their own. Instead, smiles are more likely elicited after looking at a social partner (as reported by Venezia et al., 2004). Venezia and her colleagues (2004) found that anticipatory smiling; smiling that emerges after an infant looks at a toy and before the infant looks at an experimenter, increases between 8 and 10 months. Between 8 and 12 months, typically developing infants drastically increase their use of nonverbal communication, specifically through displays of positive affect. Adamson and Bakeman (1985) suggested that such positive affect is part of infants' early attempts at social communication with others about objects (as reported by Venezia et al., 2004). Thus, as infants get older, their affective responses are extending to objects as part of the overall development of social communication with others. This explanation does not account for the significant differences found in the 6.5 month data when outliers were included, in which sib-TD infants still did not smile very much at the social stimulus. Thus, a second explanation is that the paired comparison interaction and the experimenter's call may be noticeably awkward for the infant, causing a decrease in smiling responses. It is important to note, however, that these are tentative explanations of an unexpected finding with a small sample size.

Future Directions

Although the results of this study have limited immediate implications, the data from this study can be useful in a more long-term aspect. The sib-ASD participants of this study are also a part of a much larger and extensive study, in which they will be tracked until the age of 3 years. By this age, infants with autism will have been formally diagnosed. At this time, researchers can look at the data from this specific study for those infants who do go on to develop autism or the broader phenotype, and they can look at the behavioral differences in social-nonsocial preferences and in the abilities to respond to the calls of the two stimuli that are exhibited by these infants. Similarly, the social-communicative deficits of the broader phenotype may not be significant enough to detect in the group as a whole, but would be detectable and useful in retrospect after formal diagnoses.

Final summary

This study developed a systematic method of directly comparing the responsiveness to social and nonsocial objects of infants at high (sib-ASD) and low (sib-TD) risk in a prospective study. In this study, infants at high risk for autism (who have a genetic predisposition to the disorder since they have a sibling already diagnosed with autism) and infants at lower risk for autism (infants who have no genetic predisposition and have typically developing siblings) were examined at 6.5 and 9 months. No significant differences between groups were found in infants' looking time at the social relative to the nonsocial stimulus; number of looks to the social relative to the nonsocial stimulus; reaction time to the social relative to the nonsocial stimulus; number of smiles initiated to the social relative to the nonsocial; and time to disengage from an object or a person. Significant differences were found, however, in infants' smiling time to the social versus the nonsocial stimulus. Specifically, at 9 months, lower risk, as compared to high risk infants, spent less time smiling at the experimenter's face relative to the toy. This may be due to the fact that infants' social communication progresses drastically after 8 months. Possibly, during this time, infants extend their nonverbal social communicative abilities into their interactions with objects. The other variables may prove to be useful later on for retrospective analyses once formal diagnoses have been made. A great deal of development occurs in the first year of life, and therefore, it is beneficial to define behavioral characteristics exhibited before 1 year by infants with early autism. Identifying these early markers of autism will allow an earlier onset of intervention to take place, so that infants can begin within the first year a more positive path of development before these developmental milestones are reached.

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