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Symptoms of Autism in Children Referred for Early Intervention: Implications for Theory, Diagnosis, and Research

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SYMPTOMS OF AUTISM IN CHILDREN REFERRED FOR EARLY INTERVENTION: IMPLICATIONS FOR THEORY, DIAGNOSIS, AND RESEARCH

by

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Under the Direction of Roger Bakeman, Ph.D.

ABSTRACT

Autism spectrum disorders (ASD) are neurodevelopmental disorders that affect social, communication, and behavioral development. Social impairments have been implicated as primary symptoms of ASD and communication impairments are often cited as initial concerns among parents. Yet there is an inconsistency in the literature regarding the existence of restricted interests and repetitive behaviors (RR) in very young children (i.e., those younger than 4 years) with ASD and the association between RR and sensory dysfunction. The purpose of the current project was to identify social deficits that most distinguish very young children with ASD, assess whether RR are present in very young children diagnosed with ASD, and explore the relationship between RR and sensory dysfunction. Results support the hypothesis that social impairments are primary symptoms of ASD. Stereotyped patterns of thought and behavior were present in this sample and were correlated with sensory dysfunction. Implications for theory, diagnosis, and research are discussed.

INDEX WORDS: autism, early intervention, assessment, diagnosis, autism theory

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LIST OF ABBREVIATIONS

ADI-R	Autism Diagnostic Interview – Revised
ADOS	Autism Diagnostic Observation Schedule
ASD	Autism Spectrum Disorders
BCW	Babies Can't Wait
DD	Developmentally delayed
RR	Restricted interests and repetitive behaviors
SCQ	Social Communication Questionnaire
SSP	Short Sensory Profile

1: INTRODUCTION

Autism spectrum disorders (ASD) are a set of complex neurodevelopmental disorders that affect social, communication, and behavioral development. ASD are usually detected in early childhood and can persist throughout life depending on the severity of the disorder. Understanding the developmental course of ASD, especially which characteristics are present in the first few years of life, is important for numerous reasons. Identifying children at the onset of symptom presentation leads to early intervention efforts that can improve developmental outcomes (see Rogers, 1998, for a review). Consequently, it is important to know which diagnostic symptoms are relevant to children of different ages, especially characteristics that exist in very young children. Recognizing symptoms that are pertinent to very young children can also improve general developmental screening as well as screening specifically for ASD. If the developmental profile of younger children with ASD is different from that of older children, more applicable diagnostic criteria may need to be considered for younger age cohorts (Charman & Baird, 2002; Stone, Lee, & Ashford, 1999; Tanguay, Robertson, & Derrick, 1998).

Of particular importance, the identification of symptoms relevant to very young children may shed light on primary deficits of the disorder. For instance, many researchers postulate that the core deficits in ASD involve inadequate social perception or social attention (Mundy & Markus, 1997; Tager-Flusberg, 2001). Others believe that primary deficits involve a failure to recognize the mental state of others (Baron-Cohen, Leslie, & Frith, 1985; Baron-Cohen, 1995; Baron-Cohen, 2000), a cognitive processing style in which information is processed sequentially rather than in parallel (Frith & Happe, 1994; Happe, 1994), or impairments in executive abilities such as working memory and inhibitory control (Joseph & Tager-Flusberg, 2004; Russell, 1997).

Still others believe that an impairment in assuming the psychological stance or attitude of another person lies at the heart of ASD (Hobson, 1993; Hobson, 2000; Meyer & Hobson, 2004).

Characteristics of ASD Found in Very Young Children

An investigation of the primary symptoms of ASD and how these symptoms progress during the first few years of life can demonstrate support for particular theories and shed light on symptom trajectories. For instance, theories that focus solely on higher-order cognitive skills that typically develop later in life do not adequately explain social deficits seen in infancy. In fact, there seems to be a consensus that the strongest predictors of ASD involve impairments in social interaction (i.e., failure to orient to name, failure to orient to faces, deficits in joint attention, and lack of interest in other children), which are present in the earliest developmental stages.

Research suggests that failure to orient to name and failure to orient to faces are two of the most effective predictors of ASD in young children. Early home video analyses indicate that failing to look at others and not responding to one's name most distinguish children with ASD less than 12 months of age (Baranek, 1999; Osterling & Dawson, 1994). Attention to voice also discriminates children with ASD and is one of the best predictors of autism at 2-years of age (Lord, 1995). Similarly, children 3–4 years of age show impairments in social orientation and are less likely than other children to respond to name (Dawson, Toth, Abbott, Osterling, Munson, Estes, & Liaw, 2004).

Deficits in joint attention are also strong predictors of ASD in young children. Osterling and Dawson (1994) found that impairments in joint attention (pointing, showing) discriminated infants with ASD from infants who were developing at a typical rate. Directing attention has also been found to distinguish 2-year olds referred for possible autism (Lord, 1995). Joint

attention has been found to be the single best discriminator between children with ASD, children with general developmental delays, and children with no developmental concerns who are between 3–4 years of age (Dawson et al., 2004). Similar results regarding joint attention are found in studies of ASD screening questionnaires (Baron-Cohen, Allen, & Gillberg, 1992; Baron-Cohen, Baird, Swettenham, Nightengale, Morgan, Drew, & Charman, 1996; Robins, Fein, Barton, & Green, 2001).

Lack of interest in other children is another social deficit often seen in children with ASD. An initial study investigating the Checklist for Autism in Toddlers found that one of the best predictors of ASD when a child is 18 months of age is lack of social interest (Baron-Cohen, Allen, & Gillberg, 1992). Robins and colleagues (2001) found that lack of interest in other children discriminated children with ASD from children without ASD. Lord (1995) also found that interest in other children was one of the best discriminators between children diagnosed with autism and children diagnosed with other delays.

Aside from the myriad of social deficits found in children with ASD, impairments in communication, restricted interests, and repetitive behaviors are also implicated. In fact, in order for a child to be diagnosed with ASD, he or she must exhibit delays in all 3 domains (social, communication, restricted interests/repetitive behaviors; American Psychological Association, 1994). However, the relevance of the communication and behavioral criteria to very young children with ASD has been questioned among many researchers. For instance, is lack of conversational ability an appropriate diagnostic criterion for a 2-year old child? How do restricted interests and repetitive behaviors present before 4 years of age? What does this mean in terms of diagnostic practice and developmental theory?

There is no question that delayed language skills is one of the more prominent features of ASD in young children. In a study utilizing a population-based design, Howlin and Asgharian (1999) found that delayed language, abnormal social development, and general behavior problems caused the most anxiety among parents who had a child diagnosed with ASD. DiGiacomo and Fombonne (1998) also investigated the first concerns among parents of children with ASD. Results complement those of Howlin and Asgharian (1999) in that most parents identified delayed language as their foremost concern.

Although expressive language delays are frequently seen in young children with ASD, impaired conversational skills are rarely reported in children before 4 years of age. For instance, Stone and colleagues (1999) recently questioned the feasibility of early diagnosis and whether the criteria set forth in the Diagnostic and Statistical Manual for Mental Disorders, Fourth Edition (DSM-IV, American Psychological Association, 1994) are applicable to very young children. Results found that impaired conversational skills and stereotyped language were not applicable to this age group. These results seem rather intuitive at first (especially considering developmental age), but may have important implications for theory and diagnosis. For example, the ability to attribute mental states has been associated with communication impairments found in ASD but not with measures of restricted interests and repetitive behavior or social interaction (Joseph & Tager-Flusberg, 2004). Therefore, theories of ASD that focus on higher forms of social cognition may provide important insights into characteristics that develop later in life (such as pragmatic language impairments) but not social deficits seen in infancy and early childhood.

Another diagnostic category questioned among many researchers is that of restricted interests and repetitive behaviors (RR). The DSM-IV defines RR as a preoccupation with a

restricted pattern of interests, insistence on specific and nonfunctional routines, stereotyped and repetitive motor mannerisms, and a preoccupation with parts of objects. Characteristics of this domain are often seen in older children and adults diagnosed with ASD, but their relevance to younger age cohorts is uncertain. Many researchers admit that studies on RR in ASD are lacking due to the overwhelming focus on social and communication delays (Russell, 1997). Reports that do consider RR find that a majority of parents fail to report the presence of RR during the first few years after the birth of their child. For instance, Dahlgren and Gillberg (1989) found rituals and routines did not distinguish children diagnosed with autism from children diagnosed with mental retardation or children who represented the general population. Howlin and Asgharian (1999) also found that ritualistic and stereotyped behaviors do not cause early concerns among parents of children later diagnosed with ASD.

Early home video studies and case-control designs show comparable trends. Resistance to change is rarely displayed in children from birth to 2 years of age in early home videos (Adrien, Lenoir, & Martineau, 1993). Repetitive behaviors are also not seen in similar video analyses (Baranek, 1999). Resistance to change, compulsive behaviors, and unusual attachments to objects are typically not reported in clinical samples of 2–3 year old children (Lord, 1995). Routines and rituals are not rated by clinician observers even in slightly older children (Stone, Lee, & Ashford, 1999; Stone, Hoffman, Lewis, & Ousley, 1994).

Although the DSM-IV does not include unusual sensory interests as a criterion for diagnosis, some assessment tools do consider sensory behavior in RR and general scoring algorithms (Lord, Rutter, Goode, Heemsbergen, Jordan, Mawhood, et al., 1989, Lord, Risi, Lambrecht, Cook, Leventhal, DiLavore, et al., 2000; Robins, Fein, Barton, & Green, 2001). The utility of sensory items to distinguish diagnostic groups has yielded promising results. For

instance, Dahlgren and Gillberg (1989) found that unusual reactions to sound was one of the best discriminators between children with ASD and children with cognitive impairment and children who were typically developing. Rogers, Hepburn, and Wehner (2003) found that young children with ASD differed from those with other developmental delays in tactile sensitivity, auditory sensitivity, and taste/smell sensitivity as measured by the Short Sensory Profile (Dunn, 1999). Unusual responses to sensory input have also been found to correlate with RR but not with social or communication impairments (Rogers, Hepburn, & Wehner, 2003). Consequently, some researchers believe that RR may be a consequence of poor sensory modulation (Ornitz, 1974; Ornitz, 1989) while others suggest that RR and sensory dysfunction co-occur with one another (Rogers, Hepburn, & Wehner, 2003). Yet many agree that the relationship between RR and response to sensory input deserves further investigation.

The Present Investigation

Given the pattern of data discussed above, the purpose of the current project is three-fold: (a) to identify social impairments that most distinguish very young children with ASD from others, (b) to assess whether RR are present in very young children with ASD, and (c) to explore the relationship between RR and unusual responses to sensory stimuli. It is hypothesized that characteristics that most distinguish very young children with ASD will involve impairments in social interaction as defined by a failure to orient to faces, failure to orient to name, deficits in joint attention, and lack of interest in other children. It is also hypothesized that RR will not be present in very young children with ASD but that unusual sensory interests will differentiate diagnostic groups. Finally, it is hypothesized that sensory dysfunction will be associated with RR but not with social and communication impairments.

In order to test these hypotheses, it is important to utilize standardized assessment instruments that include variables of interest and have ecological validity when administered to very young children. The American Academy of Neurology and the Child Neurology Society have developed practice parameters that recommend specific interview and observation instruments when making a diagnosis of ASD (Filipek, Accardo, Baranek, Cook, Dawson, Gordon, et al., 1999). Two of the most widely used instruments that are recommended in this report are the Autism Diagnostic Interview – Revised (ADI-R) and the Autism Diagnostic Observation Schedule (ADOS). Both the ADI-R and the ADOS include variables of interest, although individual items on the ADI-R are more descriptive of behaviors included in the RR domain. More descriptive items will allow a general measure of RR as well as exploratory analyses into specific behaviors that are relevant to young children. Thus, the ADI-R would be a more appropriate dependent variable. However, administration of the ADI-R would require many resources since the interview typically takes between 1.5–2.5 hours to administer and score (Lord, Rutter, & Le Couteur, 1994). Additionally, the ADI-R is not typically administered in clinical settings outside of the research laboratory and would place an undue burden on study participants if a comparable instrument could be identified. In summary, it would be ideal to locate a measure that is based on the ADI-R and can be administered to parents while observational assessments are being performed.

An instrument that satisfies these criteria is the Social Communication Questionnaire (SCQ, Berument, Rutter, & Lord, 1999), a brief parental screening tool used to identify children with ASD. The SCQ consists of 40 items and utilizes a simple yes/no response style. Administration typically takes 10–15 minutes to complete. Items on the SCQ were derived from the ADI-R, developed by Lord and colleagues (1994). Initial investigations of the SCQ found

that total SCQ scores are significantly correlated with total ADI-R scores (Berument, Rutter, & Lord, 1999). SCQ domain scores, including social interaction, language/communication, and RR, also correlate highly with ADI-R domain scores. Thus, the SCQ is felt to be a comparable assessment instrument for conducting the current investigation.

Screening validity for the SCQ has been supported in children 4 years of age and older; however, ongoing studies indicate that the SCQ is not as effective in identifying very young children with ASD. For instance, Hansen et al. (2002) found that the SCQ yielded good sensitivity but less adequate specificity in children 1.6–4.5 years of age. However, in an ongoing population-based investigation, Newshaffer and colleagues found that the sensitivity of the SCQ was 63% and the specificity 90% when administered to children 3–5 years of age (Newshaffer, personal communication). Wiggins (2005) replicated these findings in a clinical sample of younger children who did not have a previous ASD diagnosis (sensitivity 53% and specificity 85%). Both Newshaffer and Wiggins concluded that maximum sensitivity and specificity rates were achieved when the cutoff score was reduced from the recommended 15 to 13 total points.

The current investigation will use the SCQ, administered to children less than 4 years of age, as a means to test the aforementioned hypotheses. For purposes of this study, the definition of RR will be restricted to those SCQ items that are included in the RR domain. These items correspond with the DSM-IV definition of RR and consist of the following: hand and finger mannerisms, repetitive use of objects, verbal rituals, unusual sensory interests, compulsions and rituals, unusual preoccupations, complex body mannerisms, unusual attachment to objects, and circumscribed interests. Analyses will be conducted on each SCQ item to determine how well the item distinguishes children subsequently diagnosed with ASD from children with other developmental delays. Results will be compared to those reported by Berument, Rutter, and

Lord (1999), who had 200 participants from 4-years of age to 40-years of age (M = 12 years). The distribution for specific ages was not reported in the Berument sample. Of the 200 participants, 83 were diagnosed with autism, 9 with atypical autism, 16 with Asperger's syndrome, 7 with Fragile X syndrome, 5 with Rett syndrome, 10 with conduct disorder, 7 with specific language disorder, 15 with mental retardation, and 8 with other psychiatric diagnoses. There were more males than females diagnosed with both autism (2.8:1) and other ASD (6.7:1). The ethnic composition of the Berument sample was not reported.

Support for the current hypotheses will be gained if items involving social interaction distinguish diagnostic groups in the current sample of very young children and if items concerning RR discriminate diagnostic groups in the older sample reported by Berument, Rutter, and Lord (1999) but not in the current sample.

2: METHOD

Participants

The sample consisted of 38 families who expressed interest in participating in the study (see recruitment procedures for details on how many families were approached). One family was subsequently dropped from analyses because the child did not meet criteria for ASD on the clinical observation measure but was subsequently diagnosed with Pervasive Developmental Disorder – Not Otherwise Specified. Thus, the final sample consisted of 37 participants: 19 children with ASD and 18 children with other DD. All 37 children were under 4 years of age at the time of data collection and the sample included children both with and without a final diagnosis of ASD. Thirty of the 37 children in the sample were male. The ethnic composition of the total sample was 60% Black, 24% White, 11% Hispanic, and 5% Asian.

Children with ASD.

Nineteen children with a final diagnosis of ASD were included in the sample. Twelve of these children were formally diagnosed with autistic disorder and the others were given an autism spectrum diagnosis. Eligibility criteria for these children included: (a) must be younger than 4 years of age at the time of data collection and (b) ASD diagnosis must be confirmed by scores on the Autism Diagnostic Observation Schedule (ADOS), clinical interview, and clinical judgment.

Children with other DD.

Eighteen children with a final diagnosis of other DD were included in the sample. The diagnoses of children in the DD comparison group were general developmental delay (n = 10) and language delay (n = 8). One child in the DD comparison group had co-morbid diagnoses of sensory integration dysfunction and obsessive compulsive disorder and another child had an additional diagnosis of seizure disorder. Eligibility criteria for children in the DD comparison group included: (a) must be younger than 4 years of age at the time of data collection and (b) ASD diagnosis must be ruled out by scores on ADOS, clinical interview, and clinical judgment.

In order to reduce bias in group assignment, independent professionals administered the ADOS and made a final clinical judgment. The principal investigator administered ADOS assessments and the site developmental pediatrician assigned final clinical judgment. Clinical judgment was assigned based on all available information (i.e., ADOS scores, results of the clinical interview, school reports, other clinical reports, additional developmental assessments, etc.).

Babies Can't Wait Program

The mothers and children for this study were recruited from the Clayton County Babies Can't Wait Program (BCW). BCW is implemented under the Individuals with Disabilities Education Act and has been in existence in Georgia since 1987. The BCW program strives to identify all infants and toddlers from birth to age 3 who are experiencing developmental delays so that appropriate interventions can be provided. Eligible children are defined as children who have been diagnosed with a predetermined mental or physical condition (i.e., mental retardation, cerebral palsy, or ASD) or children who are diagnosed with significant developmental delay by a comprehensive team of BCW evaluators. Many children with significant developmental delay are given a more appropriate diagnosis after specialized evaluations are performed. Anyone, including parents and physicians, can refer children into the BCW program. Typically, children are referred into the program because they are experiencing delays in a particular area of development (i.e., delayed speech and language; Georgia Department of Human Resources, 2001).

Entry evaluations include intake interviews, a comprehensive developmental assessment, determination of eligibility, and assessment for particular types of intervention programs. An Individualized Family Service Plan is developed once all diagnostic information has been obtained. The service plan is constructed by relevant BCW team members and parents and includes specific developmental concerns, goals to be achieved, and services to be utilized. Each family is assigned a service coordinator who then manages appropriate interventions. Children are referred to other community resources when they meet the goals outlined in the service plan or when they become eligible for preschool services (Georgia Department of Human Resources, 2001).

The last public BCW annual report identified 6,978 children from birth to age 3 who were receiving services in Georgia. Of these children, 2323 were between 2–3 years of age. The following services were listed as the most common services provided by the BCW program: (a) speech/language therapy (27%), (b) physical therapy (22%), (c) special instruction (19%), and (d) occupational therapy (18%). Over 88% of services were delivered within the home. The BCW program is constantly adding new providers and resources (460 during the last public reporting period; Georgia Department of Human Resources, 2001).

The BCW program was an ideal resource for participant recruitment due to targeted age ranges and eligibility criteria (i.e., ASD are predetermined conditions that provide automatic eligibility into the program and the Clayton County BCW program has a specialized autism assessment plan for children with significant developmental delay who are displaying symptoms related to ASD). The autism assessment plan implemented in Clayton County consists of a developmental interview and physical examination of the child (conducted by the site developmental pediatrician) and administration of the ADOS (conducted by the autism assessment specialist). The developmental pediatrician reviews all available information in order to assign a final diagnosis.

Recruitment Procedures

Participants were identified as eligible for recruitment by an inventory of children who received an ADOS evaluation between March 2004 and May 2005 and who were younger than 4 years of age at the time of data collection. Fifty-four children were identified by the BCW inventory. Case managers were asked to approach each family during a routine home visit and ask if they would like to participate in the study.

Children were identified by record number only so that personally identifying information was not released to the principal investigator prior to obtaining informed consent. The inventory was forwarded to the records manager who then filed informed consent documents and parent questionnaires in identified records. Case managers introduced the consent document and study materials to the family during a weekly home visit. The case manager explained the project in detail and asked if the family would like to participate. Parents were referred to the principal investigator if they had questions that were not answered in the consent document or could not be answered by the case manager.

Case managers were utilized for recruitment because they attend routine weekly home visits with families and, therefore, were readily available to introduce the study and obtain informed consent. Case mangers were also utilized so that personal identifiers were not released to the principal investigator before informed consent was obtained. The principal investigator explained the study to all case managers and provided them with a copy of the study protocol for reference. Procedures were approved by the Georgia State University Institutional Review Board.

Measures

Data were collected from parents through the administration of the Social Communication Questionnaire (SCQ) and Short Sensory Profile (SSP) and abstraction of the clinical interview from the child's medical record. In some instances, the SCQ was previously administered during the clinical interview and was also available in the medical record. Copies of each instrument are reproduced in Appendices A–C, respectively. Brief descriptions of the instruments, including psychometric properties and time between administration of the instrument and clinician observation, are detailed below.

Social Communication Questionnaire .

The SCQ (Berument, Rutter, & Lord, 1999) is a 40-item questionnaire intended to screen children for ASD. The SCQ is designed to be completed by parents/caregivers and utilizes a simple yes/no response format. Initial investigations of the SCQ found an alpha reliability of .90 for the total score and substantial item to total score correlations of .26–.73. Validity of the SCQ was assessed with significant group differences on individual items, suggesting that items on the questionnaire did distinguish those diagnosed with ASD (Berument, Rutter, & Lord, 1999). The SCQ was administered at the time of clinical interview and, therefore, was available in the medical record for 57% of the sample. The range of months between administration of the SCQ and administration of the ADOS was 0–12 months with a mean of 3 months.

Short Sensory Profile.

The SSP (Dunn, 1999) is a 38-item questionnaire intended to assess a variety of sensory impairments. Domain scores are measured in the areas of tactile sensitivity, taste/smell sensitivity, movement sensitivity, seeking sensation, auditory filtering, low energy levels, and visual/auditory sensitivity. Each item on the SSP is measured on a 5-point Likert scale. The internal reliability of the SSP, as measured by C-ronbach's alpha, yields adequate values between .70 and .90. Internal validity was originally measured with domain to total score correlations, which were all significant at $p < .01$ (Dunn, 1999). The SSP was never administered before informed consent was obtained and was not available in the medical record of any participant. The range of months between administration of the SSP and administration of the ADOS was 1–12 months with a mean of 6 months.

Clinical interview.

The clinical interview is a semi-structured interview administered to all families in the BCW Program. The interview contains sections on pregnancy history of the mother, birth history, and developmental history of the child and is administered by the site pediatrician. Number of words in expressive vocabulary, per parental report, is recorded in the developmental history portion of the clinical interview.

Child Data Collection

Data were collected from the child through abstraction of ADOS score reports from the medical record (Appendix D) and abstraction of scores on the Battelle Developmental Inventory, if available.

ADOS.

The ADOS (Lord et al., 1989; Lord et al., 2000) is a standardized instrument in which the researcher observes the child and tries to elicit social interaction and communication using structured play activities. The examiner implements the module that best corresponds to the child's expressive language level in order to prevent language aptitude from impeding accurate diagnosis. All children in this study were administered Module 1, designed for children who are not regularly using phrase speech. Module 1 of the ADOS contains 29 scores, 17 of which are included in a final diagnostic algorithm. The final diagnostic algorithm is further divided into 4 domains: social (7 items), communication (5 items), RR (3 items), and play (2 items). Examples of items in each domain are frequency of vocalizations directed toward others (communication), unusual eye contact (social), functional play with objects (play), and unusual sensory interests (RR). Individual items are scored as 0, 1, or 2 on the diagnostic algorithm. ASD diagnosis, subsequently referred to as the ADOS total score, is determined by scores on the social and

communication domains: a score of 2 or higher on the communication domain, a score of 4 or higher on the social domain, and a score of 7 or higher on the communication and social interaction combined score must be obtained for ASD classification. The mean inter-rater reliability for Module 1 items is 92% and reliability for ASD classification is 100%. Validity has been measured with sensitivity and specificity values of 97% and 94% for autism versus ASD and 100% and 79% for children diagnosed with ASD versus children who are typically developing (Lord et al., 2000).

Battelle Developmental Inventory.

Scores from the Battelle Developmental Inventory were abstracted from the medical record when available in order to assess the mental age of the child. The Battelle Developmental Inventory (Newborg, 1984) can be administered to children from 6 months to 8 years of age and yields domain scores in the areas of communication, adaptive behavior, personal-social skills, motor development, and cognitive functioning. Test-retest reliability of children comparable in chronological age to those in the current sample is .88–.99 for all domain scores and the Battelle total score. Criterion validity was originally measured with significant correlations (i.e., .79–.94) between Batttelle area scores and domain scores on the Vineland Adaptive Behavior Scale.

Procedures Utilized for Research

Data collection occurred after informed consent was obtained. Since all children had received an ADOS assessment as part of the program evaluation, the primary caregiver completed the SCQ and SSP and the principal investigator accessed the medical record to abstract ADOS scores and clinical reports. Assessment of mental age was based on the Battelle Developmental Inventory which was abstracted from clinical reports when available. ADOS

scores were only accepted if the assessment was administered within 1 year from the time of SCQ and SSP data collection.

Final diagnosis and ADOS diagnosis was not known to the case manager or investigator at the time of SCQ administration. As mentioned previously, ADOS evaluations were completed before study enrollment and parental questionnaires were administered before ADOS scores and clinical reports were abstracted from the medical record.

3: RESULTS

Data were initially screened to ensure that variables did not display significant skew or kurtosis. Total SCQ and SSP scores produced standardized skew and kurtosis values between –1 and +1, indicating relatively normal distributions. SSP domain scores were also normally distributed and did not produce significant skew and kurtosis values. No outliers or out-of-range values were detected. Levene's test of equal variances was applied for both diagnostic groups and produced results that were not statistically significant, which demonstrates comparable variances among the primary variables of interest. These results indicate that statistical assumptions were met and that research questions can be explored using parametric techniques.

One-way ANOVAs were performed to verify that diagnostic groups were comparable in terms of chronological age, mental age, and expressive language level. Recall that mental age was calculated by the abstraction of scores on the Battelle Developmental Inventory, which were available for 70% of the sample. Descriptive statistics of these variables are provided in Table 1. Children with ASD and children with DD did not differ in terms of chronological age, F (1, 35) = .66, η^2 = .02, p = .42; mental age, F (1, 24) = .09, η^2 = .00, p = .77; or expressive language level per parental report, F (1, 35) = .69, η^2 = .02, p = .41. Due to the heterogeneity in chronological age (i.e., 17–45 months), correlations were conducted to probe whether variations

in age could be related to any differences found among the dependent variables. Results indicated that chronological age was not significantly associated with total scores on the SCQ, $r = -.07$, $p = .70$, SSP, $r = -.02$, $p = .90$, or ADOS, $r = .07$, $p = .69$.

Table 1. *Descriptive Statistics of Sample*

	DD		ASD	
Variable	*M (range)*	*N*	*M (range)*	*N*
Chronological age	32 (17–45)	18	34 (20–44)	19
Mental age	24 (16–45)	13	24 (15–32)	13
Words in expressive vocabulary (per parental report)	21 (4–50)	18	15 (0–100)	19

Note. Chronological and mental ages are reported in months.

SCQ Analyses

Sensitivity and specificity.

Previous investigations of the SCQ have revealed relatively low sensitivity in children younger than 4 years of age, suggesting that specific items may not be relevant to younger age populations (Newshaffer, personal communication; Wiggins, 2005). In the current investigation, sensitivity and specificity calculations were performed in order to replicate these findings and provide a rationale for comparing items on the SCQ across different age populations. Sensitivity of the SCQ was determined by how many children were correctly identified with ASD and specificity was estimated by correct identification of children in the DD comparison group. As recommended by Berument, Rutter, and Lord (1995), a cutoff score of 15 was employed, that is, children who scored 15 or higher on the SCQ were categorized as potentially having an ASD.

The range of SCQ scores was 1–20 for children with DD and 2–25 for children with ASD. With a cutoff score of 15, the SCQ correctly identified 9 of 19 children with ASD and 16 of 18 children with DD, yielding a sensitivity of 47% and a specificity of 89%. Sensitivity improved to 68% and specificity remained at 89% when the cut-off score was reduced to 13. However, maximum sensitivity and specificity rates were achieved when the cut-off score was reduced to 11 (89% and 89%, respectively; see Table 2). Next, individual SCQ items were compared to assess which items were not distinguishing the children with ASD, resulting in the low sensitivity estimates for these young children when using the traditional 15 cutoff score.

Table 2. *SCQ Sensitivity and Specificity at Variable Cutoff Scores*

SCQ Cutoff Score	*Sensitivity*	*Specificity*
15	47%	89%
13	68%	89%
11	89%	89%

Analyses of individual SCQ items.

Chi-square analyses were performed on each SCQ item to further explore study hypotheses. Again, it was hypothesized that items that most distinguished young children with ASD could be categorized as impairments in social interaction, RR would not discriminate ASD and DD groups, and that young children with ASD would have more unusual responses to sensory input than children with DD. Results were compared to those of Berument, Rutter, and Lord (1999) whose participants were between 4–40 years of age with a mean age of 12 years. Findings from the current investigation, as well as those from Berument and colleagues, can be

found in Tables 3–5. Chi-squares were computed using Yate's Correction of Continuity, which compensates for the over-estimation of Pearson Chi-square when used with a 2 by 2 design. Results are not reported for the first 8 items since these items were dependent on the child's use of phrase speech and all children received an ADOS Module 1, which is only appropriate for children who do not regularly use phrase speech.

As predicted, items that most distinguished children with ASD primarily loaded on the social domain. These items included lack of eye gaze, does not share enjoyment, no attention to voice, inappropriate facial expressions, does not offer to share, minimal range of facial expressions, no social smiling, and does not show and direct attention. It is worth noting that 7 of these 8 items were never endorsed by parents of children in the DD comparison group: lack of eye gaze, does not share enjoyment, no attention to voice, inappropriate facial expressions, minimal range of facial expressions, no social smiling, and does not show and direct attention. Social items that discriminated children with ASD in the Berument sample but failed to do so in the current investigation were lack of interest in unfamiliar children, no group play, positive response to approaches of unfamiliar children, offers comfort to respondent, imaginative play with peers, quality of social overtures, and has special friends. Associated Chi-square and significance values are provided in Table 3.

Table 3. *Comparison of SCQ Social Items Across Reports*

SCQ Item	*% Endorsed by Diagnostic Group*		χ^2 *current sample*	χ^2 *Berument et al., 1999*
	DD	ASD		
Offers to share	**94**	**53**	**6.2***	**27.8****
Interest in unfamiliar children	83	53	2.7	**24.3*****
Group play	67	44	1.0	**11.2*****
Positive response to approaches of unfamiliar children	83	79	.0	**26.1*****
Offers comfort to respondent	72	47	1.5	**32.8*****
Shows and directs attention	**100**	**74**	**3.5**^{a}	**26.0*****
Seeks to share enjoyment	**100**	**47**	**10.5*****	**16.3*****
Imaginative play with peers	67	42	.0	**29.2*****
Social smiling	**100**	**68**	**4.7***	**10.5*****
Appropriate eye gaze	**100**	**42**	**12.2*****	**19.9*****
Attention to voice	**100**	**53**	**8.4****	**15.7*****
Range of facial expressions	**100**	**68**	**4.7***	**19.6*****
Quality of social overtures	100	79	2.4	**18.3*****
Has special friends	22	16	.0	**5.6****
Appropriate facial expressions	**100**	**58**	**7.4****	**4.0***
Use of other's body to communicate	72	47	1.5	**8.9****

Note. Bolded text indicates items that distinguished diagnostic groups in both reports
[a] $p = .06$
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

The only item in the RR domain that distinguished children with ASD was complex body mannerisms. The item that assessed unusual sensory interests was not found to be endorsed more by parents in the ASD sample than parents in the DD sample. As predicted, there were many items within the RR domain that did not differentiate the diagnostic groups. Items that produced significant values in Berument's report but not in the current investigation included hand and finger mannerisms, repetitive use of objects, compulsions and rituals, unusual preoccupations, unusual attachment to objects, and circumscribed interests. Associated Chi-square and significance values are provided in Table 4.

Table 4. *Comparison of SCQ RR Items Across Reports*

SCQ Item	*% Endorsed by Diagnostic Group*		χ^2 *current sample*	χ^2 *Berument et al, 1999*
	DD	ASD		
Hand and finger mannerisms	28	42	.3	33.4***
Repetitive use of objects	28	42	.3	9.4**
Unusual interest in sensory input	17	47	2.7	6.5*
Compulsions and rituals	39	42	.0	5.2
Unusual preoccupations	11	32	1.2	21.0***
Complex body mannerisms	**5**	**47**	**6.2***	**12.7*****
Unusual attachment to objects	22	16	.0	3.2a
Circumscribed interests	28	32	.0	7.6**

Note. Bolded text indicates items that distinguished diagnostic groups in both reports
[a] $p = .07$
* $p < .05$, ** $p < .01$, *** $p < .001$

Of note, there were several items on the communication domain that discriminated children with ASD from children with DD, including social chat, nodding to mean yes, imitative social play, pointing to express interest, and head shaking to mean no. Similar to some of the social items previously discussed, lack of imitative social play was never endorsed by parents of children in the DD comparison group. Communication items that did not distinguish diagnostic groups included spontaneous imitation, imaginative play with other children, and gestures other than pointing to indicate wants. Associated Chi-square and significance values for SCQ communication items can be found in Table 5.

Table 5. *Comparison of SCQ Communication Items Across Reports*

SCQ Item	*% Endorsed by Diagnostic Group*		χ^2 *current sample*	X^2 *Berument et al, 1999*
	DD	ASD		
Imitative social play	**100**	**53**	**8.8****	**19.2*****
Spontaneous imitation	78	58	.9	20.0***
Pointing to express interest	**94**	**47**	**7.7****	**25.1*****
Imaginative play with other children	67	42	1.4	38.9***
Gestures other than pointing to indicate wants	72	53	.8	14.7***
Head shaking to mean "no"	**94**	**53**	**6.2***	**26.4*****
Nodding to mean "yes"	**78**	**16**	**11.9*****	**26.1*****
Social chat	**83**	**21**	**12.0*****	**7.4****

Note. Bolded text indicates items that distinguished diagnostic groups in both reports
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

SSP Analyses

SSP data were missing for 3 study participants. Hence, all SSP analyses were conducted with a total of 34 participants. Differences between SSP total scores and domain scores were investigated with separate ANOVA analyses. Since multiple analyses increase the likelihood of Type I error, an alpha level of .01 was chosen for all ANOVA analyses. Results indicated a significant difference in SSP total scores between children diagnosed with ASD and those diagnosed with DD, F (1, 32) = 26.8, $p < .001$. As Table 6 illustrates, ASD classification accounted for the most variance in tactile sensitivity, followed by auditory sensitivity and taste/smell sensitivity. There were no significant differences between diagnostic groups in the areas of movement preoccupation, sensory under-responsiveness, low energy levels, or visual/auditory sensitivity.

Table 6. *ANOVA Source Table for SSP Domain Scores*

	DD	ASD			
SSP Domain	*M (SD)*	*M (SD)*	*F*	*P*	η^2
Tactile sensitivity	28.9 (2.8)	22.1(4.0)	33.6	<.001	.51
Auditory sensitivity	23.1 (3.8)	16.6 (4.0)	23.9	<.001	.43
Taste/smell sensitivity	16.0 (4.0)	11.6 (5.3)	7.5	.01	.19
Visual/auditory sensitivity	19.8(2.8)	18.4 (2.0)	2.8	.10	.08
Low energy levels	28.4 (1.0)	26.9 (4.4)	1.3	.26	.04
Under-responsive	25.8 (5.7)	24.4 (4.5)	.7	.41	.02
Movement preoccupation	13.0 (2.8)	13.1 (1.6)	.0	.88	.00

To further explore the sensory profile among children with ASD, additional ANOVA analyses were performed on SSP item scores from the three domains that showed significant group differences. Items that produced significant group differences in the tactile sensitivity domain included difficulty standing close to others, expresses distress during grooming, unusual reaction to touch, and avoids going barefoot. Difficulty paying attention, lack of response to voice, does not respond to name, and cannot work with background noise contributed to group differences in auditory sensitivity. Finally, there was a difference in the following items within the taste/smell domain: limits self to certain textures or temperatures, avoids certain tastes, is a picky eater, and avoids certain tastes or smells. Associated significance values and measures of effect size are given in Table 7.

Table 7. *ANOVA Source Table for SSP Items Scores*

	DD	ASD			
SSP Item	*M (SD)*	*M (SD)*	*F*	*P*	η^2
Tactile sensitivity					
Difficulty standing close to others	4.2 (1.1)	2.2 (.8)	34.7	<.001	.52
Expresses distress during grooming	3.6 (1.2)	1.8 (.7)	27.7	<.001	.46
Unusual reaction to touch	4.4 (1.1)	3.1 (1.0)	13.4	.001	.30
Avoids going barefoot	4.5 (.6)	3.3 (1.4)	11.6	.002	.28
Prefers clothing opposite to weather conditions	4.4 (.7)	3.8 (1.1)	2.7	.111	.08
Rubs or scratches a spot that has been touched	4.1 (.8)	3.7 (1.1)	1.5	2.30	.05
Withdraws from splashing water	3.8 (1.1)	3.8 (.9)	.0	1.00	.00
Auditory sensitivity					
Difficulty paying attention	3.5 (.9)	1.9 (.9)	28.6	<.001	.47
Lack of response to voice	3.7 (.9)	2.0 (1.0)	24.7	<.001	.44
Does not respond to name	3.7 (.9)	2.1 (1.1)	20.6	<.001	.39
Cannot work with background noise	4.4 (.9)	3.2 (1.1)	11.0	.002	.26
Is distracted if there is noise around	3.8 (1.0)	3.3 (1.0)	2.0	.170	.06
Has trouble completing tasks with the radio on	4.2 (1.0)	3.9 (.9)	.9	.351	.03
Taste/smell sensitivity					
Limits self to certain textures or temperatures	4.3 (1.1)	2.7 (1.3)	15.2	<.001	.32
Avoids certain tastes	4.2 (1.2)	3.0 (1.2)	9.9	.004	.24
Picky eater	3.5 (1.2)	2.4 (1.2)	8.2	.007	.20
Avoids certain tastes or smells	3.9 (1.3)	3.0 (1.0)	5.6	.024	.15

ADOS Analyses

To further evaluate study hypotheses, one-way ANOVAs were performed to assess the relative performance of children with ASD and children with DD on the ADOS. An alpha level of .01 was chosen for all ADOS analyses. As expected, children with ASD scored significantly higher on the ADOS total score than children with DD. To explore whether social deficits alone accounted for this difference, or if diagnostic groups also performed differently within the communication and RR areas, additional ANOVA analyses were conducted on the three domain scores. It is important to note that Levene's test suggested equal variances between diagnostic groups in social and RR measures, but not within the communication domain. As Table 8 and Figure 1 demonstrate, a significant difference between diagnostic groups was detected within the social domain; 76% of the variance in ADOS social scores can be accounted for by diagnostic group assignment. There was also a significant difference in communication scores; 70% of the variance in ADOS communication scores can be accounted for by diagnostic group assignment. However, ADOS RR scores also produced significant results, suggesting that children with ASD displayed more RR during clinical assessment than did children with DD. Results found that 40% of the variance in ADOS RR scores could be accounted for by diagnostic group assignment.

Table 8. *ANOVA Source Table for ADOS Total and Domain Scores*

	DD	ASD			
Score	*M (SD)*	*M (SD)*	*F*	*p*	η^2
Total score	2.4 (2.1)	15.2 (4.0)	141.7	<.001	.80
Social domain	1.6 (1.8)	9.8 (2.8)	112.1	<.001	.76
Communication domain	.9 (.9)	5.4 (1.9)	83.0	<.001	.70
RR domain	.4 (.7)	2.0 (1.2)	23.7	<.001	.40

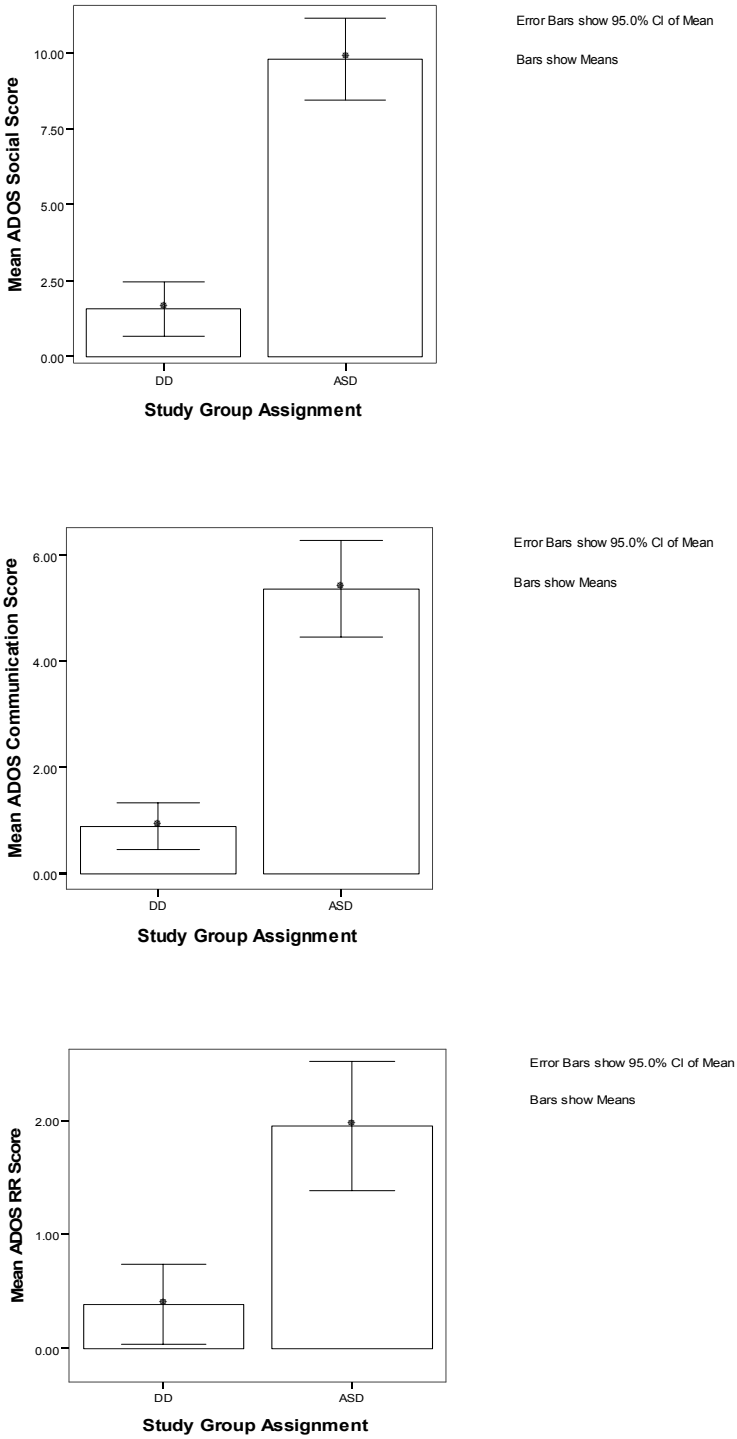

Figure 1. Mean ADOS Domain Scores and 95% Confidence Intervals for Diagnostic Groups.

Exploratory analyses were next performed in order to investigate the relationship between RR domain and item scores and the ADOS total score. Most RR items were rarely endorsed for children in the DD comparison group and previous investigations have found relatively high correlations between items (Lord, Risi, & Lambrecht, 2000). Thus, since multicollinearity and unequal variances were expected, a bivariate correlation matrix was created for the analysis. In contrast to predictions, RR domain scores were correlated with the ADOS total score, $r = .65$, $p < .001$, and with ADOS social and communication domain scores, $r = .65$, $p < .001$ and $r = .58$, $p < .001$; respectively. Further analysis revealed that each of the items included in the RR domain were correlated with the ADOS total score: unusual or repetitive interests, $r = .54$, $p < .001$; unusual response to sensory input, $r = .36$, $p = .03$; and complex body mannerisms, $r = .33$, $p = .05$. Two of the RR items that were correlated with the ADOS total score were not reported by parents on the SCQ (i.e., unusual or repetitive interests and unusual responses to sensory input). It is also worth noting that for the ASD case group, SSP total scores yielded a significant correlation with ADOS RR domain scores, $r = –.63$, $p = .006$, but not with ADOS social or communication scores, $r = –.08$, $p = .77$ and $r = –.11$, $p = .67$, respectively. Table 9 outlines the frequency of ADOS item scores for children with ASD and children with DD.

Table 9. *Frequency of ADOS Algorithm Item Scores for Respective Diagnostic Groups*

	Frequency of Score (0, 1, 2)	
ADOS Item	DD	ASD
Social		
Unusual eye contact	16, N/A, 2	3, N/A, 16
Facial expressions directed toward others	4, 14, 0	4, 9, 6
Shared enjoyment in interaction	13, 5, 0	4, 10, 5
Showing	17, 1, 0	1, 7, 11
Spontaneous initiation of joint attention	17, 1, 0	4, 6, 9
Response to joint attention	14, 3, 1	5, 2, 12
Quality of social overtures	11, 7, 0	0, 4, 15
Communication		
Frequency of vocalization directed to others	16, 1, 1	0, 1, 18
Stereotyped use of words or phrases	17, 0, 1	14, 1, 4
Use of others body to communicate	16, 2, 0	14, 0, 5
Pointing	13, 5, 0	1, 10, 8
Gestures	16, 2, 0	7, 11, 1
RR		
Unusual sensory interests	17, 1, 0	14, 3, 2
Hand and finger and other complex mannerisms	17, 0, 1	11, 5, 3
Repetitive interests or stereotyped behaviors	15, 2, 1	4, 11, 4

4: DISCUSSION

The present study sought to explore three hypotheses: (a) social impairments differentiate very young children with ASD more than other diagnostic domains, (b) RR do not distinguish very young children with ASD, and (c) very young children with ASD have more abnormal responses to sensory input than young children with DD. Each hypothesis will be addressed, in turn, in the following sections.

Social Impairments in Very Young Children with ASD

The first study hypothesis was that very young children with ASD would be most distinguished from children with DD by impairments in social interaction. It was further supposed these impairments would be illustrated by a failure to orient (to faces and to name), deficits in joint attention, and lack of interest in other children. Individual SCQ item analyses and examination of ADOS domain scores offer strong support for the proposed hypothesis. Results found that SCQ items often endorsed by parents of children with ASD, but never reported by parents of children with DD, were almost exclusively items in the social domain. These items included lack of eye gaze, does not share enjoyment, no attention to voice, inappropriate facial expressions, minimal range of facial expressions, no social smiling, and does not show and direct attention. Interest in other children failed to distinguish children with ASD from children with DD in this young sample. As Table 10 illustrates, similar findings are consistently reported in studies utilizing samples of very young children, suggesting that impairments in social reciprocity may be crucial to understanding the nature of ASD (Adrien, 1993; Baranek, 1999; Lord, 1995; Mars, 1998; Osterling & Dawson, 1994; Stone, et al., 1999).

Table 10. *Social Impairments Implicated in Very Young Children with ASD*

Behavior	≤ 1 year	2 years	3 years
Eye gaze	A, B, O, M	A, M, L	L
Seeking to share enjoyment	O	L, S	L
Response to name	A, B, O	A, L	L
Appropriate facial expressions	A	A	L
Range of facial expressions	B	L	L
Joint attention	O, M	M, L	L
Social smiling	A	A	

Note. A = Adrian, 1993; B = Baranek, 1999; L = Lord, 1995; M = Mars, 1998; O = Osterling & Dawson, 1994; S = Stone et al., 1999.

The social items that did not distinguish diagnostic groups in the present sample were interest in other children, participation in group play, positive response to other children's approaches, offers comfort, imaginative play with peers, quality of social overtures, has special friends, and use of other's body to communicate; all of which can be explained in terms of developmental age. For instance, imaginative play with peers and the presence of special friends would not be expected in a group of 2–3 year old children who are developmentally delayed, or even among those who are typically developing. Items that assess these characteristics may be inappropriate for inclusion on screening and diagnostic instruments that attempt to distinguish very young children with ASD from other clinical populations. Accordingly, alternative diagnostic algorithms should be considered for younger age cohorts (Stone, 1999).

One item that failed to discriminate study groups was the use of another's body to communicate. There is an inconsistency in the literature about the ability of this item to discriminate 2–3 year old children with ASD from same-aged DD peers. For instance, Lord

(1995) found that 2 year old children with autism used another's body as a tool more often than children with DD and was one of 5 symptoms that correctly identified all children with autism at 3 years of age. Cox and colleagues (1999) failed to replicate this finding when examining the stability of clinical and ADI-R diagnoses. In the present analyses, parents reported that children with DD also exhibited the tendency to use another's body as a tool. Yet one must keep in mind that most of the children in the current sample had some form of language delay. In fact, 44% of the children in the DD comparison group were formally diagnosed with language delay or language disorder. As a result, the finding that 72% of parents of children with DD endorsed this item could represent language compensation among children with DD.

ADOS analyses also offered clear support for the hypothesis that impairments in social reciprocity most distinguish very young children with ASD. Results found that 76% of the variance in ADOS social scores can be accounted for by study group assignment, which is the largest effect found for any diagnostic domain. Again, these findings suggest that impairments in social interaction may be primary symptoms of ASD that offer the key to understanding the nature of this complex and multifaceted disorder and which is important for screening, diagnosis, and developmental theory. In terms of diagnosis, results indicate that impairments in social interaction should be given utmost priority on screening instruments and diagnostic algorithms for very young children. Additionally, theories that ponder the core deficits of ASD should incorporate hypotheses on social deficits seen in infancy and how these deficits relate to developmental course. For instance, Hobson and Meyer (2004) have suggested that the core deficit in ASD is an impairment in relating to one's self in terms of another person (or understanding the psychological stance of another person), which subsequently leads to deficits in understanding mental states and reciprocal social interaction. This hypothesis, which

addresses early characteristics of ASD and their relationship to developmental trajectory, is more comprehensive than theories that focus solely on cognitive skills expected to develop later in life.

RR in Very Young Children with ASD

The second study hypothesis was that RR, excluding abnormal responses to sensory stimuli, would not distinguish very young children with ASD from young children with other DD. This hypothesis was based on an inconsistency in the literature on the presence of RR in young children. SCQ results found that 1 of 8 items included in the current analysis discriminated study groups, whereas 7 of the same 8 items distinguished study groups in the older sample reported by Berument and colleagues (Berument, Rutter, & Lord, 1999). The only item endorsed more often by parents of children with ASD in both studies was the presence of complex body mannerisms.

At first glance, these findings seem to support the hypothesis that RR are not consistently present in very young children with ASD when compared to DD peers. However, exploration of ADOS domain scores found that children with ASD displayed more RR during clinical assessment than did children with DD. The effect size associated with this difference was .40, reflecting a large effect. Further analyses revealed a significant correlation between each of the ADOS RR items, including hand and finger mannerisms, unusual or repetitive interests, and abnormal responses to sensory input, and the ADOS total score. The presence of unusual or repetitive interests has not been consistently reported in the literature but is found in some studies that utilized experienced clinicians as observers (Lord, 1995). These findings indicate that although unusual or repetitive interests are not reported by parents at this young age, they are detected by clinicians trained in ASD assessment and diagnosis.

A discrepancy between parental report and clinician observation has been documented in numerous studies (Bishop & Norbury, 2002; De Bildt, Sytema, Katelaars, Kraijer, Volkmar, F., & Minderaa, 2003; De Bildt, Sytema, Katelaars, Kraijer, Mulder, Volkmar, & Minderaa, 2004; Stone, Hoffman, Lewis, & Ousley, 1994), some of which directly compared the ADOS to the ADI-R. In a recent investigation on the early diagnosis of ASD, Moore and Goodson (2003) reported obvious disagreement between parental report and clinician observation and remedied the discrepancy by reaching clinical consensus after data collection. The authors concluded that the diagnosis of ASD in very young children should always be supplemented with experienced clinical judgment and information obtained from a variety of sources. Additionally, previous studies that utilized a parent report measure as the only dependent variable and failed to find RR in young children deserve more detailed analysis.

Results of the current investigation have numerous implications for developmental theory, autism research, and clinical practice. Findings suggest that RR are present in very young children with ASD and that each of the diagnostic domains are significantly correlated with one another and with a comprehensive assessment of symptom severity. These results support original observations reported by Kanner (1943) and Wing and Gould (1979) that define ASD as a disorder characterized by both impairments in social interaction and the presentation of restricted, repetitive, and stereotyped pattern of behaviors, interests, and activities. Due to the robust and positive correlations between RR and other diagnostic domains, it seems reasonable to assume that children with RR are more likely to display significant deficits in social interaction and communication. In fact, RR are often related to the severity of social and communication impairments and to autism (versus ASD) diagnosis (Charman & Swettenham, 2001). Additionally, findings suggest that RR are present in very young children who have not

developed advanced cognitive skills. Thus, theories that relate RR to higher-order processing skills do not adequately explain the presence of these behaviors early in development. For instance, Turner (1997) has suggested that impairments in executive functioning abilities can account for the existence of RR in 1 of 2 ways: (a) impaired inhibitory control leads to repetition in thought and behavior and (b) the inability to generate novel behavior leads to repetition of actions that exist in a small behavioral repertoire. Yet executive functioning abilities are typically not measured in children younger than 4 years of age and, as results indicate, RR do exist in these young children.

Furthermore, findings from several investigations, including the present analysis, should encourage both parental report and clinician observation during research and clinical assessment. Some studies suggest that parents tend to report the absence of typically developing behaviors but not the presence of subtle atypical behaviors (Stone, Lee, & Ashford, 1999). Although data from the current investigation support such a hypothesis, the exact nature of reporting discrepancies is an area of study that warrants future research.

Sensory Symptoms in Very Young Children ASD

The third major purpose of the present analysis was to explore abnormal responses to sensory input among very young children with ASD. As predicted, children with ASD did display more abnormal responses to sensory input than children with DD, especially in the areas of tactile sensitivity, auditory sensitivity, and taste/smell sensitivity. These findings replicate those of previous investigations that used a comparable sample and methodological approach (Rogers, Hepburn, & Wehner, 2003): Significant group differences were reported within the exact same sensory domains. Furthermore, the present analysis failed to detect group differences

in the areas of under-reactivity, visual/auditory input, low energy levels/weak, and movement; again replicating results of previous studies (Rogers, Hepburn, & Wehner, 2003).

Further analysis revealed specific items that were contributing to group differences in sensory regulation. The author is aware of only one other study that probed individual items assessing sensory dysfunction in children with ASD (Kientz & Dunn, 1996). However, the sample used in this previous investigation included children 3–13 years of age; no comparable investigation has been conducted with children the same age as those included in the current study. Therefore, the findings of the present analysis are the first to be reported about children with ASD referred for early intervention. Results suggest that, within the tactile sensitivity domain, items that distinguished study groups included difficulty standing close to others, distress during grooming, unusual reaction to touch, and avoids going barefoot. Two of these items, expresses distress during grooming and has difficulty standing in line or close to other people, were reported as always occurring or occurring more than 50% of the time in the Kientz and Dunn (1996) report. Results of the auditory sensitivity analysis found differences in difficulty paying attention, lack of response to voice, does not respond to name, and cannot work with background noise. It is interesting to note that two of these items, lack of response to voice and does not respond to name, also produced significant group differences on the SCQ. Again, these findings suggest that failure to orient to voice may be a primary symptom of ASD that is especially relevant in younger age populations. Finally, there were significant group differences in limits self to certain textures or temperatures, avoids certain tastes, is a picky eater, and avoids certain smells.

One interesting finding that deserves consideration is the correlation between the SSP and ADOS RR domain score, but not social and communication scores, among children with ASD.

This trend was also found by Rogers, Hepburn, and Wehner (2003); the authors subsequently suggested an independent relationship between symptom sets. Yet the consistent replication of this association could indicate a co-occurrence of RR and sensory dysfunction or that RR are consequences of poor sensory modulation. Indeed, this latter theory has been proposed by others, some who believe that poor sensory modulation is a core symptom of ASD that manifests as RR and social and communication impairments (Ayres, 1979; Ornitz, 1974; Ornitz, 1989). Although the insignificant association between the SSP and ADOS social and communication scores do not support this hypothesis, the relationship between sensory modulation, RR, and ASD symptom severity should be addressed in future research.

Limitations

The present study utilized a relatively small sample size, which may have prevented detection of statistically significant differences between diagnostic groups on individual SCQ and SSP items. However, study results did find statistical differences on items implicated in previous research, suggesting that these items are relevant to the targeted population. Additionally, measures of effect size suggest moderate to large effects for SSP and ADOS analyses. Another limitation was the moderately low mental age and language delay among study participants (i.e., the mean mental age was 24 months and none of the children were regularly using phrase speech). One implication of this limitation is that differences found within the RR domain could only apply to children with mental ages around 24 months or those with significant developmental delays. Future research is needed to assess whether current findings can be replicated in a sample of children with less cognitive and developmental delay.

Another consideration is the heterogeneity among diagnostic groups, especially among children subsequently diagnosed with ASD. Descriptive statistics showed a rather broad array of

developmental levels: the chronological age range was 17–45 months and the mental age range was 15–45 months. Additionally, children with ASD were diagnosed very early in life and may or may not continue to display characteristics of ASD after treatment offered by the early intervention program. Although previous investigations suggest the diagnosis of ASD is relatively stable in young children (Cox et al., 1995; Lord, 1995), the stability of diagnosis is most associated with a diagnosis of autism instead of a diagnosis of ASD. Thus, since only 12 of the 19 children in the ASD group were diagnosed with autism, findings should be interpreted with caution.

Summary

The present study investigated the developmental profile of very young children with ASD. Results support the hypothesis that impairments in social reciprocity most distinguish children with ASD younger than 4 years of age. RR, including unusual or repetitive interests, were detected during clinical assessment and were significantly correlated with sensory dysfunction. Children with ASD also had more abnormal responses to sensory input than children with other DD, especially in the areas of tactile sensitivity, auditory sensitivity, and taste/smell sensitivity. Items that produced group differences in each of these sensory domains measure characteristics consistently found to differentiate very young children with ASD from their DD peers.

Findings suggest that impairments in social reciprocity should be given utmost priority when screening and diagnosing very young children with ASD. Of particular importance are assessments that measure lack of eye gaze, does not share enjoyment, no attention to voice, inappropriate facial expressions, minimal range of facial expressions, no social smiling, and impairments in joint attention. Developmental theorists should also heed these findings given

that similar characteristics are continuously found to be most predictive of ASD in very young children. More specifically, developmental theories that ponder the core deficits of ASD but do not consider early social impairments are seriously lacking. The challenge is to now assess the earliest social markers of ASD and how the development of these markers relates to etiology and developmental trajectory. Many promising research groups are currently attempting to address such questions (Meyer & Hobson, 2004).

Study results also found that RR, including unusual or repetitive interests, are present in very young children with ASD and are significantly correlated with sensory dysfunction. As mentioned previously, these results support original observations reported by Kanner (1943) and Wing and Gould (1979) that define ASD as a disorder characterized by both impairments in social interaction and restricted or repetitive behaviors and interests. Yet parental report alone is inadequate to assess the presence of RR; such accounts should always be supplemented with experienced clinical judgment. Since tactile sensitivity, auditory sensitivity, and taste or smell sensitivity consistently distinguish very young children with ASD, items that assess these characteristics should be considered in ASD diagnostic algorithms. Furthermore, the relationship between RR and sensory dysfunction deserves further examination, specifically whether these domains of deficit simply co-occur or whether RR are consequences of poor sensory modulation.

The limitations of the study qualify but do not negate the implications of these results. Findings offer strong support for the theory that social impairments are the key to understanding ASD and should be the primary focus of screening and assessment procedures, of clinical and developmental research, and when generating theories on core deficits of the disorder. Findings also support original assumptions that restricted, repetitive, and stereotyped behaviors and

interests are significant aspects of ASD that distinguish the disorder from other clinical populations. Moreover, RR are associated with abnormal responses to sensory input, which is also implicated in children with ASD during the first few years of life. Future research should implement more longitudinal designs with larger samples in order to gain a more comprehensive understanding of these domains of deficit and how their relationships change over the course of development.

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APPENDIX A: THE SOCIAL COMMUNICATION QUESTIONNAIRE

Is she/he now able to talk using short phrases or sentences? If no skip to question 8.	Yes	No
Do you have a to and fro conversation with her/him that involves taking turns or building on what you have said?	Yes	No
Does she/he ever use odd phrases or say the same thing over and over in almost exactly the same way (either phrases that she-he hears other people use or ones that she/he makes up)?	Yes	No
Does she/he ever use socially inappropriate questions or statements?	Yes	No
Does she/he ever get her/his pronouns mixed up?	Yes	No
Does she/he ever use words that she/he seems to have invented or made up her/himself; put things in odd, indirect ways; or use metaphorical ways of saying things?	Yes	No
Does she/he ever say the same thing over and over in exactly the same way or insist that you say the same thing over and over again?	Yes	No
Does she/he ever have things that she/he seems to have to do in a very particular way or order or rituals that she/he insists that you go through?	Yes	No
Does her/his facial expression usually seem appropriate to the particular situation, as far as you can tell?	Yes	No
Does she/he ever use your hand like a tool or as if it were a part of her/his own body (e.g., pointing with your finger or putting your hand on a doorknob to get you to open the door)?	Yes	No
Does she/he have any interests that preoccupy her/him and might seem odd to other people (e.g., traffic lights, drainpipes, or timetables)?	Yes	No
Does she/he ever seem to be more interested in parts of a toy or an object (e.g., spinning the wheels of a car) rather than using the object as it was intended?	Yes	No
Does she/he ever have any special interests that are *unusual* in their intensity but otherwise appropriate for her/his age and peer group (e.g., trains or dinosaurs)?	Yes	No
Does she/he ever seem to be *unusually* interested in the sight, feel, sound, taste, or smell of things or people?	Yes	No
Does she/he have any mannerisms or odd ways of moving her/his hands or fingers, such as flapping or moving her/his fingers in front of her/his eyes?	Yes	No
Does she/he ever have any complicated movements of her/his whole body, such as spinning or repeatedly bouncing up and down?	Yes	No
Does she/he ever injure her/himself deliberately, such as biting her/his arm or banging her/his head?	Yes	No
Does she/he ever have any objects (other than a soft toy or comfort blanket) that she/he *has* to carry around?	Yes	No

Does she/he have any particular friends or a best friend?	Yes	No
Does she/he ever talk with you just to be friendly (rather than to get something)?	Yes	No
Does she/he ever *spontaneously* copy you (or other people) or what you are doing (such as vacuuming, gardening, or mending things)?	Yes	No
Does she/he ever spontaneously point at things around her/him just to show you not because she/he wants them)?	Yes	No
Does she/he ever use gestures, other than pointing or pulling your hand, to let you know what she/he wants?	Yes	No
Does she/he nod her/his head to indicate *yes*?	Yes	No
Does she/he shake her/his head to mean *no*?	Yes	No
Does she/he usually look at you directly in the face when doing things with you or talking with you?	Yes	No
Does she/he smile back when someone smiles at her/him?	Yes	No
Does she/he ever show you things that interest her/him to engage your attention?	Yes	No
Does she/he ever offer to share things other than food with you?	Yes	No
Does she/he ever seem to want you to join in her/his enjoyment of something?	Yes	No
Does she/he ever try to comfort you is you're sad or hurt?	Yes	No
If she/he wants something or wants help, does she/he look at you and use gestures with sounds or words to get your attention?	Yes	No
Does she/he show a normal range of facial expressions?	Yes	No
Does she/he ever spontaneously join in and try to copy the action in social games such as *The Mulberry Bush* or *London Bridge is Falling Down*?	Yes	No
Does she/he ever play any pretend or make-believe games?	Yes	No
Does she/he seem interested in other children of approximately the same age whom she/he does not know?	Yes	No
Does she/he respond positively to when another child approached her/him?	Yes	No
If you come into a room and start talking to her/him without calling her/his name, does she/he usually look up and pay attention to you?	Yes	No
Does she/he ever play imaginative games with another child in such a way that you can tell that each child understands what the other is pretending?	Yes	No
Does she/he play cooperatively in games that need some form of joining in with a group of other children, such as hide-and-seek or ball games?	Yes	No

APPENDIX B: THE SHORT SENSORY PROFILE

Instructions: Please check the box that **best** describes the frequency with which your child does the following behaviors.

	Always (1)	Frequently (2)	Occasionally (3)	Seldom (4)	Never (5)
Tactile Sensitivity					
Expressed distress during grooming (for example fights or cries during haircutting, face washing, fingernail cutting)					
Prefers long-sleeved clothing when it is warm or short-sleeved clothing when it is cold					
Avoids going barefoot, especially in sand or grass					
Reacts emotionally or aggressively to touch					
Withdraws from splashing water					
Has difficulty standing in line or close to other people					
Rubs or scratches out a spot that has been touched					
Taste/Smell Sensitivity					
Avoids certain tastes or food smells that are typically part of children's diets					
Will only eat certain tastes (list:_____)					
Limits self to certain food textures/temperatures (list:_____)					
Picky eater, especially regarding food textures					
Movement Sensitivity					
Becomes anxious or distressed when feet leave the ground					
Fears falling or heights					
Dislikes activities where head is upside down (for example, somersaults, roughhousing)					
Underresponsive/Seeks Sensation					
Enjoys strange noises/seeks to make noise for noises sake					
Seeks all kinds of movement and this interferes with daily routines (for example, can't sit still, fidgets)					

Becomes overly excitable during movement activity

Touches people and objects

Doesn't seem to notice when face or hands are messy

Jumps from one activity to another so that it interferes with play

Leaves clothing twisted on body

Auditory Filtering

Is distracted or has trouble functioning if there is a lot of noise around

Appears not to hear what you say (for example, does not "tune in" to what you say, appears to ignore you)

Can't work with background noise (for example, fan, refrigerator)

Has trouble completing tasks when the radio is on)

Doesn't respond when name is called but you know the child's hearing is OK

Has difficulty paying attention

Low Energy/Weak

Seems to have weak muscles

Tires easily, especially when standing or holding particular body positions

Has a weak grasp

Can't lift heavy objects (for example, weak in comparison to same age children)

Props to support self (even during activity)

Poor endurance/tires easily

Visual/Auditory Sensitivity

Responds negatively to unexpected or loud noises (for example, cries or hides at noise from vacuum cleaner, dog barking, hair dryer)

Holds hands over ears to protect ears from sound

Is bothered by bright lights after others have adapted to the light

Watches everyone when they move around the room

Covers eyes or squints to protect eyes from light

APPENDIX C: COMPONENTS OF BCW CLINICAL INTERVIEW

1. Chief Complaint
2. Past History
    a. Birth history
    b. Early developmental history
3. Developmental Milestones
    a. Motor
    b. Language
    c. Activities of daily living
    d. Behavior
4. Medical History
    a. Illnesses
    b. Surgery
    c. Trauma
    d. Hospitalizations
    e. Current physician
    f. Immunization
    g. Allergies
    h. Medications
    i. Programs attended
5. Review of Systems
    a. Hearing and vision
    b. Chest
    c. Cardiovascular
    d. Gastrointestinal
    e. Urinary tract
    f. Central nervous system
6. Family History
7. Social History
8. Physical Examination
    a. Height
    b. Weight
    c. Head circumference
    d. General
    e. Skin
    f. HEENT
        i. Head
        ii. Eyes
        iii. Ears
        iv. Nose
        v. Throat
    g. Neck
    h. Chest
    i. Cardiovascular
    j. Abdomen
    k. Genitalia
    l. Back
    m. Extremities

Neurological

9. Developmental Assessment
10. Diagnoses
11. Recommendations

APPENDIX D: ADOS MODULE 1 DIAGNOSTIC ALGORITHM

Domain	Items (scored 0, 1, or 2)
Communication (4 = Autism cut-off, 2 = ASD cut-off)	Frequency of vocalizations directed to others Stereotyped/idiosyncratic use of words or phrases Use of other's body to communicate Pointing Gestures
Reciprocal Social Interaction (7 = Autism cut-off, 4 = ASD cut-off)	Unusual eye contact Facial expressions directed toward others Shared enjoyment I interaction Showing Spontaneous initiation of joint attention Response to joint attention Quality of social overtures
Play	Functional play with objects Imagination/creativity
Stereotyped Behaviors and Restricted Interests	Unusual sensory interest in play material/person Hand and finger and other complex body mannerisms Unusual repetitive interests or stereotyped behaviors

Note. The total score is the sum of the Communication and Social Interaction Domains; 12 = Autism cut-off, 7 = ASD cut-off