NIH Public Access

Author Manuscript

Res Autism Spectr Disord. Author manuscript; available in PMC 2011 April 5.

Published in final edited form as:
Res Autism Spectr Disord. 2009 ; 3(4): 959–966. doi:10.1016/j.rasd.2009.05.003.

Relationships among Repetitive Behaviors, Sensory Features, and Executive Functions in High Functioning Autism

Brian A. Boyd, **Matthew McBee**, **Tia Holtzclaw**, **Grace T. Baranek**, and **James W. Bodfish**
University of North Carolina at Chapel Hill

Abstract

This study examined the relationship between repetitive behaviors and sensory processing issues in school-aged children with high functioning autism (HFA). Children with HFA (*N* = 61) were compared to healthy, typical controls (*N* = 64) to determine the relationship between these behavioral classes and to examine whether executive dysfunction explained any relationship between the variables. Particular types of repetitive behavior (i.e., stereotypy and compulsions) were related to sensory features in autism; however, executive deficits were only correlated with repetitive behavior. This finding suggests that executive dysfunction is not the shared neurocognitive mechanism that accounts for the relationship between restricted, repetitive behaviors and aberrant sensory features in HFA. Group status, younger chronological age, presence of sensory processing issues, and difficulties with behavior regulation predicted the presence of repetitive behaviors in the HFA group.

Keywords

Autism Spectrum Disorder; Repetitive Behaviors; Sensory Features; Executive Function

Repetitive behaviors comprise one faction of the triad of clinical symptoms that characterize autism spectrum disorder (ASD), presenting concomitantly with social and communication deficits. Restricted, repetitive behaviors (RRBs) in autism refer to an assemblage of behaviors defined by their topographical similarity across contexts, inappropriateness, and repetition. These behaviors have been conceptualized as part of a continuum that ranges from lower order (stereotypy, self-injury) to higher order (compulsions, rituals /sameness, restricted interests) (Carcani-Rathwell, Rabe-Hasketh, & Santosh, 2006; Cucarro et al., 2003; Hus, Pickles, Cook, Risi, & Lord, 2006; Turner, 1999). Higher order behaviors, specifically the presence of restricted/narrow interests, odd object attachments or unusual object preoccupations (e.g., fascination with ceiling fans), are thought to be more unique to autism in comparison to other types of repetitive behaviors (e.g., self-injury) (Lam, Bodfish, & Piven, 2008).

In contrast to repetitive behaviors, sensory features in autism are considered secondary or associated symptoms of the disorder. Sensory processing issues may manifest behaviorally

Corresponding Author: Brian A. Boyd, Ph.D., Investigator, University of North Carolina at Chapel Hill Phone: 919-962-6035 Fax: 919-966-7532 boyd@mail.fpg.unc.edu. Address for Reprint Requests: Frank Porter Graham Child Development Institute, 517 S. Greensboro St., Carrboro, NC 27150.

through hyporesponsiveness (under-reactivity to environmental stimuli), hyperresponsiveness (over-reactivity to stimuli), or sensory seeking (craving/fascination with sensory stimuli) (Ben-Sasson et al., 2009; Liss, Sauliner, Fein, & Kinsbourne, 2006). Aberrant sensory features are presumed to be less specific and universal in autism than the triad of core features, although there is some evidence that hyporesponsiveness is more associated with autism (Baranek, David, Poe, Stone, & Watson, 2006). In a recent study, Gabriel et al (2008) reported a relationship between high rates of RRBs and abnormal sensory responses in a subgroup of 70 school-aged children with ASD, and this relationship was not affected by the child's chronological age or IQ level. It is possible that the relationship between sensory features and repetitive behaviors in autism can be explained by shared neurocognitive mechanisms.

The clinical presentation of repetitive behaviors in autism has been linked to deficits in executive functioning (Turner, 1999). Executive function is an umbrella term for a set of subfunctions that are integrated throughout cortical and subcortical areas of the brain and used to carry out higher order cognitive tasks (O'Hearn, Asato, Ordaz, & Luna, 2008; Zelazo, Carter, Reznick, & Frye, 1997). Turner (1999) implicated deficits in the executive subfunctions of response inhibition, cognitive flexibility /set shifting and generativity in the expression of repetitive behaviors in autism. More recently, Lopez, Lincolon, Ozonoff, and Lai (2005) found that poor cognitive flexibility best predicted the occurrence of repetitive behaviors in a sample of adults with autism. Overall the evidence is mixed about the relationship between RRBs and executive deficits in autism, and it is unlikely that executive dysfunction is the primary explanatory model of these behaviors (Lopez et al., 2005; Zandt, Prior, & Kyrios, 2009). Still it is important to examine if executive deficits also could account for the presence of sensory issues in autism. This will allow researchers to determine whether executive dysfunction is a shared mechanism that explains the relationship between these behavioral classes.

Presently, there is a paucity of research on potential shared mechanisms that underlie repetitive and sensory behaviors; in addition, less is known about how these behaviors manifest in high functioning children with autism. Using a cross-sectional study design, Esbensen, Seltzer, Lam, and Bodfish (2009) found that repetitive behaviors typically abate over the lifespan of an individual with autism, although some types of repetitive behavior (e.g. stereotypy) show less of a decrease when there are co-morbid intellectual impairments. Previous researchers have reported an association between lower IQ levels and repetitive behaviors in autism (Bodfish, Symons, Parker, & Lewis, 2000; Bishop, Reichler, & Lord, 2006). However, the repetitive behavior of restricted/narrow interests are thought to be more prevalent in HFA or Asperger's Syndrome, which are both characterized by average to above average intelligence (South, Ozonoff, & McMahon, 2005).

Sensory symptoms in autism also are impacted by cognitive maturation, at least in preschool-aged children. Researchers have found that lower mental ages are predictive of aberrant sensory features in young children with autism or other developmental disabilities (Baranek et al., 2006; Baranek, Boyd, Poe, David, & Watson, 2007). Few research studies have been conducted on the clinical expression of sensory features in older children with HFA. Smith-Myles et al. (2004) found that school-aged children diagnosed with Asperger's Syndrome had more sensory processing problems than children with ASD based on caregiver report; however, this study did not control for differences in IQ between the groups. Further, Ashburner, Ziviani, and Rodger (2008) found that aberrant sensory processing (under-responsiveness, sensory seeking, and auditory filtering difficulties) problems were a predictor of poorer academic performance in a sample of children with HFA, whereas only IQ predicted academic performance for typical peers. Additional studies are needed to determine if aberrant sensory features and repetitive behaviors present differently in HFA than in typical comparisons, and to determine the underlying mechanisms that could account for any relationship between these behaviors. The purpose of this study was to examine (1) the relationship between sensory features and repetitive behaviors in high functioning school-aged children with autism, (2) whether executive deficits are correlated with both classes of behaviors, and (3) the variables that predict the presence of repetitive behaviors in HFA.

Method

Participants

Study participants included 61 children diagnosed with ASD and 64 children who were typically developing (TYP). The ASD group was comprised of individuals diagnosed with Autistic disorder (N = 31), Asperger's Syndrome (N = 22), Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS; N = 5), and ASD (unspecified; N = 3). All ASD and TYP participants met the following general inclusion criteria: (a) between 6 and 17 years of age, (b) IQ greater than 70, (c) absence of a seizure disorder, (d) no acute medical or genetic condition, and (e) absence of an uncorrected visual impairment. Participants with ASD were recruited through the University of North Carolina (UNC) Autism Research Registry in conjunction with regional TEACCH (Treatment and Education of Autistic and related Communication-handicapped Children) diagnostic clinics. Inclusion in the research registry required a previous DSM-IV diagnosis of ASD made by an independent, licensed clinician experienced in the assessment and diagnosis of autism. In addition, participants had to meet ASD diagnostic criteria on validated autism diagnostic assessments. Following referral from the registry, all ASD participants were evaluated again by trained research personnel to confirm the participants met study inclusion criteria using the Autism Diagnostic Interview-Revised (ADI-R; LeCouteur, Lord, & Rutter, 2003) to examine lifetime criteria for ASD, the Social Communication Questionnaire (SCQ; Rutter, Bailey & Lord, 2003) to examine current severity of autism symptoms, and the Leiter International Performance Scale-Revised (Leiter-R; Roid & Miller, 1997) to examine general cognitive ability. Typically developing children were recruited via a mass e-mail sent to UNC faculty and staff. Study investigators excluded TYP children for the following reasons: (a) history of any psychiatric or developmental disorder, (b) currently taking psychotropic medication, (c) immediate family member with an ASD diagnosis, or (d) child received a score above the ASD cutoff on the SCQ.

The groups did not differ on gender, χ^2 (1), = .01, p = .94, or race χ^2 (4), = 3.26, p = .515. The TYP group (M age in months = 141.02) was significantly older than the ASD group (M = 122.64, t (123) = 2.78, p = .006), and the TYP group (M = 111.16) had a significantly higher IQ score than the ASD group (M = 99.97, t(123) = 3.87, p < .001). Within the ASD group, participants on medication (N = 25) (M = 25.32) had significantly higher RBS-R total scores than those not on medication (N = 36) (M = 18.56, t(59), p = .048). However, both the ASD medication group and ASD non-medication group had significantly higher RBS-R scores than the TYP group (M = 1.22, p <.0001); thus, we left the data for the two ASD groups combined for comparison purposes. For the ASD medication group, the types of medications were categorized as CNS stimulants (N = 9), typical antipsychotics (N = 1), atypical antipsychotics (N = 5), SSRI antidepressants (N = 15), Non-SSRI antidepressants (N = 3), Antiepileptics (N = 2), Alpha-2 agonists (N = 6), and Norephinephrine agonists (N = 9); these categories are not mutually exclusive as participants may have been taking more than one type of medication. Sensory Questionnaire scores did not differ significantly by medication status, t(45) = -0.57, p = 0.574.

See Table 1 for further description of the sample. Prior to participating in the study, all individuals and their legal guardians supplied written informed consent and assent. The

UNC-Chapel Hill School of Medicine Biomedical Institutional Review Board approved the protocol for this study. For the purposes of this study, the primary caregiver of the child with autism completed the informant-based measures.

Measures

Repetitive behaviors—The Repetitive Behavior Scale-Revised (RBS-R; Bodfish et al., 1999; Lam & Aman, 2007) is an informant-based questionnaire that assesses 43 discrete types of repetitive behaviors across 6 subscales (Stereotypy, Self-injurious Behavior, Compulsions, Rituals, Sameness, Restricted Interests). Scores for each item on the measure range from 0 (behavior does not occur) to 3 (behavior occurs and is severe). Lam and Aman (2007) conducted a factor analysis (based on $N = 320$ caregivers of individuals with autism) that generated a five factor solution with Rituals and Sameness loading on the same factor. Factor loadings ranged from 0.51 - 0.66, accounting for 47.5% of the variance; internal consistency of the scales ranged from 0.78 - 0.91 and inter-rater reliability ranged from 0.57 - 0.73 (see Lam and Aman, 2007). The factor scores were used for data analysis.

Sensory features—The Sensory Questionnaire (SQ; Boyd & Baranek, 2005) is an informant-based questionnaire designed to capture sensory processing issues specific to children with autism. A total of $N = 103$ ($N = 47$ for ASD, $N = 56$ for TYP) caregivers completed the SQ; fewer participants completed this measure because it was added to the study protocol later in the project. The six item questionnaire measures whether the child currently (within the last 3 months) or ever (not demonstrated within the last 3 months but demonstrated in the past) displayed sensory processing issues. Using the study sample, a confirmatory factor analysis was conducted to examine the psychometric properties of the SQ and to determine the most appropriate scoring method. The best scoring approach appears to be summing the “current” and “ever” scores yielding a zero to two score for each item. Item 6 on the SQ (question related to synesthesia) did not load on the same factor as the other items, and was not included in subsequent data analysis. Factor loadings for items one to five ranged from 0.71 - 0.89. The confirmatory factor analysis indicated that a single factor model for items one through five fit well, χ^2 (5) = 4.33, p = .503, CFI = 1.00, RMSEA < .001. There were no overlapping items between the RBS-R and SQ.

Executive functioning—The Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kentworthy, 2000) is an informant-based rating scale (teacher and parent versions) used to assess executive deficits in children between 5 - 18 years of age. The BRIEF yields a composite score and two indices: Behavioral Regulation (3 subscales: Inhibition, Shifting Attention, Emotional Control) and Metacognition (5 subscales: Initiating, Working Memory, Planning/Organizing, Organization of Materials, Monitoring). The BRIEF has high internal consistency (alphas = .80-.98) and test-retest reliability ($r = .82$ for parents and .88 for teachers). Normative data were based on child ratings from a diverse group of 1,419 parents and 720 teachers; in addition, children with HFA were included in the clinical sample.

Results

The means and standard deviations for the RBS-R, SQ, and BRIEF are included in Table 2. The ASD group scored significantly higher than typical comparisons on all subscales and the total/composite scores of these measures. An independent samples t-test was used to examine group differences between the ASD and TYP groups for repetitive behavior, sensory features, and executive functioning. In all analyses, the t-test assumed unequal variances resulting in a significant difference ($p < .0001$).

Group Differences in Repetitive Behaviors

The mean group difference (i.e., difference in the mean value between the two groups) is reported for the 5 factor-derived RBS-R subscale scores and the total score. The mean values per group can be found in Table 2. For Stereotypy, the mean group difference was -5.09 with 95% confidence interval [-6.12, -4.06]. For Self-injury, the mean group difference was -2.37 with 95% confidence interval [-3.03, -1.70]. For Compulsions, the mean group difference was -2.76 with 95% confidence interval [-3.52, -2.01]. For Sameness behaviors, the mean group difference was -7.06 with 95% confidence interval [-8.48, -5.64]. For Restricted Interests, the mean group difference was -2.83 with 95% confidence interval [-3.38, -2.29]. For the RBS-R total score, the mean group difference was -20.11 with 95% confidence interval [-23.41, -16.80].

Group Differences in Sensory Issues

Based on the SQ composite score, the mean group difference was -5.18 with 95% confidence interval [-5.92, -4.45].

Group Differences in Executive Functioning

For the BRIEF Behavior Regulation Index, the mean group difference was -24.22 with 95% confidence interval [-27.37, -21.08]. For the Metacognition Index, the mean group difference was -22.75 with 95% confidence interval [-25.74, -19.77]. For the BRIEF composite score, the mean group difference was -25.46 with 95% confidence interval [-28.39, -22.53].

Relationship between RBS-R, SQ, and BRIEF

Pearson correlation coefficients were used to examine relationships between the three measures within the ASD group. The SQ composite score was moderately correlated with the Stereotypy ($r = 0.41$, $p = .004$) and Compulsions ($r = 0.34$, $p = .020$) subscales of the RBS-R and the total score ($r = 0.35$, $p = .017$). Only the Behavioral Regulation Index of the BRIEF was moderately correlated with the RBS-R subscales of Self-injury ($r = 0.38$, $p = .003$), Compulsions ($r = 0.39$, $p = .002$), Rituals/Sameness ($r = 0.40$, $p = 0.002$) and the RBS-R total score ($r = 0.43$, $p = .001$). No significant correlations were found between the BRIEF and the SQ composite score. See Table 3 for correlations between the three measures.

Regression Analysis

A regression analysis was used to predict the RBS-R total score. The outcome variable was log-transformed prior to analysis to produce residuals that were approximately normal. Because the natural log of zero is undefined, and many individuals in the TYP group had scores of zero on the RBS-R, an offset of 0.50 was added to the scores prior to transformation. The residuals obtained after transformation were approximately normal but exhibited slight heteroskedastisticity. Robust standard errors were utilized to correct for any resulting underestimation of the standard errors that could lead to an inflated risk of Type I error. All predictor variables were centered to their values in the typical group. The variables that best predicted the clinical expression of repetitive behaviors using the RBS-R total score were group (TYP vs. ASD; $b = 1.706$, $p < 0.001$), chronological age in months ($b = -0.004$, $p = 0.031$), SQ composite score ($b = 0.097$, $p = 0.026$), and the BRIEF Behavioral Regulation Index ($b = 0.033$, $p = 0.003$). A diagnosis of ASD, lower chronological age, and higher scores on the SQ and the BRIEF Behavioral Regulation Index were predictive of more repetitive behaviors. The combination of these variables resulted in $r^2 = 0.86$, thus these variables accounted for 86% of the variance in the total RBS-R score. Mothers' ($p = 0.092$) or fathers' education levels ($p = 0.469$), Leiter-R IQ scores ($p = 0.577$), and BRIEF Metacognition scores ($p = 0.200$) were not predictive of RBS-R scores.

Discussion

In the present study, school-aged children with HFA had significantly higher scores than their typical peers on all caregiver-report measures of symptomatology. Caregivers reported that children with HFA had more restricted repetitive behaviors, sensory processing issues, and executive functioning impairments. These findings are consistent with previous studies that have reported differences in the frequency, severity and/or developmental trajectory of these behaviors in individuals with ASD in comparison to typical controls (see Honey, Leekam, Turner, & McConachie, 2007 for RRB differences; see Luna, Doll, Hegedus, Minshew, & Sweeney, 2007 for EF differences; see Baranek et al., 2006; Rogers, Hepburn, & Wehner, 2003; Talay-Ongan & Wood, 2000 for sensory differences).

In examining the relationship between these symptom domains, we found that sensory processing issues, as measured by the SQ, were correlated with the presence of stereotypies, compulsions, and the total score on the RBS-R. This is consistent with the findings of Gabriels and colleagues (2008), who reported a relationship between abnormal sensory responses and repetitive behaviors in children with ASD, irrespective of the child's IQ level or chronological age. The findings from the regression analysis suggest that repetitive behaviors were more prevalent in younger children in our sample; however, IQ was not a predictor of the expression of these behaviors in the ASD group. This may be due to the exclusion of participants with an IQ below 70.

To our knowledge, there has not been any previous research on the relationship between executive dysfunction and sensory features of ASD. The current study did not find a relationship between executive deficits and sensory processing issues. There is mixed evidence on the relationship between executive dysfunction and repetitive behaviors in autism (Lopez et al., 2005; Zandt et al., 2009). In the current study, only the Behavioral Regulation Index of the BRIEF was correlated with repetitive behaviors and predictive of the clinical expression of these behaviors in ASD. This suggests that executive dysfunction is not the shared mechanism that underlies the relationship between sensory processing issues and repetitive behaviors in high functioning autism. Other studies would need to replicate this finding to further substantiate this claim. It is possible that neurobiological instead of neurocognitive mechanisms better explain the relationship between these behavioral classes.

This study is novel in its attempt to investigate executive dysfunction as a potential shared mechanism that explains the relationship between sensory processing issues and repetitive behaviors in high functioning autism. However there are limitations to the study design. First, only caregiver report measures were used to investigate the relationship between the behaviors. Observational measures of sensory and repetitive behaviors and executive functioning are needed to validate caregiver report, and to obtain a better understanding of these clinical phenomena. Second, there is a need to examine the range of functioning levels in autism to determine if this relationship is found for children with more significant cognitive impairments. It is important to point out that even though the TYP group had significantly higher IQ scores than the ASD group, we did not find that IQ predicted the expression of repetitive behaviors. Finally, we did not explore the relationship between sensory features and repetitive behaviors in the typical comparison group because they displayed low frequencies of these abnormal behaviors; however, it may be important to examine if the relationship holds for other clinical groups who display these behaviors (e.g., Fragile-X syndrome). Future studies should investigate if the relationship between sensory symptoms and repetitive behaviors differs as a function of type of sensory issue (i.e., hyperresponsive, hyporesponsive, or sensory seeking) or type of repetitive behavior (i.e., higher order or lower order).

Acknowledgments

This research was supported in part by a grant from the NIH (R01 MH73402). We thank the families whose participation made this study possible. We also thank Renee Clark and the NDRC Research Registry for their recruitment efforts.

References

Ashburner J, Ziviani J, Rodger S. Sensory processing and classroom emotional, behavioral, and educational outcomes in children with autism spectrum disorder. The American Journal of Occupational Therapy. 2008; 62:564–573. [PubMed: 18826017]

Baranek GT, Boyd BA, Poe M, David F, Watson LR. Hyperresponsive sensory patterns in young children with autism, developmental delay, and typical development. American Journal of Mental Retardation. 2007; 112:233–245. [PubMed: 17559291]

Baranek GT, David FJ, Poe MD, Stone WL, Watson LR. The Sensory Experiences Questionnaire: Discriminating response patterns in young children with autism, developmental delays, and typical development. Journal of Child Psychology and Psychiatry. 2006; 47:591–601. [PubMed: 16712636]

Ben-Sasson A, Hen L, Fluss R, Cermak S, Engel-Yeger B, Gal E. A meta-analysis of sensory modulation symptoms in individuals with autism spectrum disorders. Journal of Autism and Developmental Disorders. 2009; 39:1–11. [PubMed: 18512135]

Boyd, BA.; Baranek, GT. Sensory Questionnaire (SQ). University of North Carolina; Chapel Hill: 2005. Unpublished manuscript

Bishop S, Reichler J, Lord C. Association between restricted and repetitive behaviors and nonverbal IQ in children with autism spectrum disorders. Child Neuropsychology. 2006; 12:247–267. [PubMed: 16911971]

Bodfish JW, Symons FJ, Lewis MH. The Repetitive Behavior Scales (RBS). Western Carolina Center Research Reports. 1999

Bodfish JW, Symons FJ, Parker DE, Lewis MH. Varieties of repetitive behavior in autism: Comparison to mental retardation. Journal of Autism and Developmental Disabilities. 2000; 30:237–243.

Carcani-Rathwell I, Rabe-Hasketh S, Santosh P. Repetitive and stereotypical behaviors in pervasive developmental disorders. Journal of Child Psychology and Psychiatry. 2006; 47:573–581. [PubMed: 16712634]

Cuccaro ML, Shao Y, Grubber J, Slifer M, Wolpert CM, Donnelly SL, et al. Factor analysis of restricted and repetitive behaviors in autism using the Autism Diagnostic Interview-R. Child Psychiatry and Human Development. 2003; 34:3–17. [PubMed: 14518620]

Esbensen A, Seltzer MM, Lam KSL, Bodfish JW. Age-related differences in restricted repetitive behaviors in autism spectrum disorders. Journal of Autism and Developmental Disorders. 2009; 39:57–66. [PubMed: 18566881]

Gabriel R, Agnew J, Miller J, Gralla J, Pan Z, Goldson E, et al. Is there a relationship between restricted, repetitive, stereotyped behaviors and interests and abnormal sensory response in children with autism spectrum disorders? Research in Autism Spectrum Disorders. 2008; 2:660–670.

Gioia, G.; Isquith, P.; Guy, S.; Kentworthy, L. The Behavior Rating Inventory of Executive Function (BRIEF). Psychological Assessment Resources, Inc.; Lutz, FL: 2000.

Honey E, Leekam S, Turner M, McConachie H. Repetitive behavior and play in typically developing children and children with autism spectrum disorder. Journal of Autism and Developmental Disorders. 2007; 37:1107–1115. [PubMed: 17072748]

Hus V, Pickles A, Cook E, Risi S, Lord C. Using the Autism Diagnostic Interview-Revised to increase phenotypic homogeneity in genetic studies. Biological Psychiatry. 2006; 61:438–448. [PubMed: 17276746]

Lam KSL, Aman MG. The Repetitive Behavior Scale—Revised: Independent validation in individuals with autism spectrum disorders. Journal of Autism and Developmental Disorders. 2007; 37:855–866. [PubMed: 17048092]

Lam KSL, Bodifsh JW, Piven J. Evidence for three subtypes of repetitive behavior in autism that differ in familiarity and association with other symptoms. Journal of Child Psychology and Psychiatry. 2008; 49:1193–1200. [PubMed: 19017031]

Le Couteur, A.; Lord, C.; Rutter, M. Autism Diagnostic Interview-Revised (ADI-R). Western Psychological Corporation; Los Angeles: 2003.

Liss M, Saulnier C, Fein D, Kinsbourne M. Sensory and attention abnormalities in autism spectrum disorders. Autism. 2006; 10:155–172. [PubMed: 16613865]

Lopez BR, Lincoln AJ, Ozonoff S, Lai Z. Examining the relationship between executive functions and restricted, repetitive symptoms of autistic disorder. Journal of Autism and Developmental Disorders. 2005; 35(4):445–460. [PubMed: 16134030]

Luna B, Doll S, Hegedus S, Minshew N, Sweeney J. Maturation of executive function in autism. Biological Psychiatry. 2007; 61:474–481. [PubMed: 16650833]

O'Hearn K, Asato M, Ordaz S, Luna B. Neurodevelopment and executive function in autism. Development and Psychopathology. 2008; 20:1103–1132. [PubMed: 18838033]

Rogers SJ, Hepburn S, Wehner E. Parent reports of sensory symptoms in toddlers with autism and those with other developmental disorders. Journal of Autism and Developmental Disorders. 2003; 33(6):631–42. [PubMed: 14714932]

Roid, GH.; Miller, LJ. Leiter International Performance Scale Revised. Stoelting Co.; Wood Dale, IL: 1997.

Rutter, M.; Bailey, A.; Lord, C. Social Communication Questionnaire (SCQ). Western Psychological Services; Los Angeles: 2003.

Smith Myles B, Hagiwara T, Dunn W, Rinner L, Reese M, Huggins A, et al. Sensory issues in children with Asperger syndrome and autism. Education and Training in Developmental Disabilities. 2004; 39:283–290.

South M, Ozonoff S, McMahon WM. Repetitive behavior profiles in Asperger syndrome and high-functioning autism. Journal of Autism and Developmental Disorders. 2005; 35:145–158. [PubMed: 15909401]

Talay-Ongan A, Wood K. Unusual sensory sensitivities in autism: A possible crossroads. International Journal of Disability, Development and Education. 2000; 47(2):201–212.

Turner M. Annotation: Repetitive behavior in autism: A review of psychological research. Journal of Child Psychology and Psychiatry. 1999; 40:839–849. [PubMed: 10509879]

Zandt F, Prior M, Kyrios M. Similarities and differences between children and adolescents with autism spectrum disorders and those with obsessive compulsive disorder: Executive functioning and repetitive behavior. Autism. 2009; 13:43–57. [PubMed: 19176576]

Zelazo PD, Carter A, Reznick JS, Frye D. Early development of executive function: A problem-solving framework. Review of General Psychology. 1997; 1:198–226.

Table 1

Demographic and Clinical Features of Participants

Variable	ASD Group Mean (SD)	TYP Group Mean (SD)
Chronological Age (months)	122.64 (33.38)	141.02 (40.03)
Leiter-R (Brief IQ)	99.67 (17.30)	111.16 (15.85)
Gender (% male)	93.44%	93.75%
Ethnicity (% Caucasian)	81.97%	76.56%
Medications (% on meds)	40.98%	0%

Table 2

Means and Standard Deviations for RBS-R, SQ, and BRIEF

Variable	N	ASD Group Mean (SD)	N	TYP Group Mean (SD)
RBS-R Total	61	24.71 (13.19)	64	1.22 (2.13)
RBS-R Stereotypy	61	5.25 (4.13)	64	0.16 (0.54)
RBS-R Self-injury	64	2.46 (2.65)	64	0.09 (0.35)
RBS-R Compulsions	61	2.93 (3.01)	64	0.17 (0.52)
RBS-R Sameness	61	7.56 (5.62)	64	0.50 (1.11)
RBS-R Restricted Interests	61	3.13 (2.10)	64	0.30 (0.66)
SQ Composite	47	6.02 (2.43)	56	0.84 (1.22)
BRIEF Behavior Regulation	60	67.57 (11.29)	64	43.34 (5.66)
BRIEF Metacognition	57	67.25 (9.64)	63	44.49 (8.14)
BRIEF Composite	57	69.02 (9.71)	63	43.56 (6.23)

Note: RBS-R = Repetitive Behavior Scales-Revised, SQ = Sensory Questionnaire, BRIEF = Behavior Rating Inventory of Executive Function. All t-tests resulted in a significant difference, $p < .001$. Higher scores indicate more impairment.

Table 3

Correlations between measures, ASD group (n = 61)

	RBS-R Total	RBS-R Stereo.	RBS-R Self-injury	RBS-R Compulsions	RBS-R Rit./Same	RBS-R Res. Int	BRIEF Beh. Reg.	BRIEF Metacog.	BRIEF Comp.	SQ Comp.
RBS-R Total	1.000									
RBS-R Stereotypy	.802*	1.000								
RBS-R Self-injury	.467*	.333*	1.000							
RBS-R Compulsions	.810*	.663*	.157	1.000						
RBS-R Rituals/Sameness	.864*	.498*	.194	.681*	1.000					
RBS-R Res. Int	.645*	.375*	.276*	.337*	.554*	1.000				
BRIEF Beh. Reg.	.430*	.222	.383*	.388*	.399*	.150	1.000			
BRIEF Metacog.	.069	.069	.099	.056	.017	.048	.519*	1.000		
BRIEF Composite	.224	.125	.231	.202	.178	.093	.807*	.920*	1.000	
SQ Composite	.345*	.406*	.013	.340*	.265	.218	.114	.009	.033	1.000

Note:

* indicates $p < .05$