


Parent-Reported Repetitive Behavior in Toddlers on the Autism Spectrum

Hannah H. Schertz¹  · Samuel L. Odom² · Kathleen M. Baggett³ · John H. Sideris²

Published online: 26 July 2016
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Abstract Toddlers with autism spectrum disorder (ASD) were assessed on the Repetitive Behavior Scale-Revised (RBS-R), which we found to have acceptable internal consistency. Stereotypical subscale scores showed a negligible association with cognitive level, but correlated more strongly with adaptive and social indicators. Relative to earlier reported RBS-R scores for older age groups, toddlers' scores trended toward higher stereotyped behavior and lower ritualistic/sameness behavior. Our findings on associations with developmental indicators align with those of researchers who used more resource-intensive repetitive behavior measures. The convergence of these findings with those derived from other measurement methods suggests that the RBS-R, a cost effective parent-report measure, is a viable means of assessing repetitive behavior in toddlers with autism.

Keywords Repetitive and restrictive behavior · Repetitive Behavior Scale-Revised · Toddlers with autism

Introduction

Studies of repetitive and restrictive behavior (RRB) in toddlers with autism, although only recently emerging, are beginning to converge around common findings derived from varied measurement processes. Together, this research attests to RRB's early appearance in autism, divergence from typical development, change during the toddler period, differentiation among RRB subtypes, and association with other developmental domains. One under-explored area is whether assessment of RRB in toddlers with autism is reliable using accessible cost-effective measures and whether such instruments yield associations with developmental functioning that are similar to those generated from more time-intensive observational coding measures and parent interviews. An additional gap concerns how RRB changes from early to late toddlerhood in autism based on such measures and how these changes compare to those occurring over the lifespan.

Repetitive behavior is not unique to young children with autism, as it occurs in typical development with patterns that progress in synchrony with motor, vocal, and neurological maturation during infancy (Ejiri and Masataka 2001; Thelen 1979).

Typically, high rates of lower order motor stereotypies beginning in the first year continue into the second (Arnott et al. 2010) and merge into higher order forms during the 2- to 4-year age period (Evans et al. 1997). However, despite its occurrence in typical early development, it is now well established that RRB's greater duration and severity in toddlers with autism distinguish them as a group from both

✉ Hannah H. Schertz
hschertz@indiana.edu

Samuel L. Odom
slodom@unc.edu

Kathleen M. Baggett
kbaggett@ku.edu

John H. Sideris
john.sideris@unc.edu

¹ Department of Curriculum and Instruction, Indiana University School of Education, 201 N Rose Ave., Bloomington, IN 47405, USA

² Frank Porter Graham Child Development Institute, University of North Carolina, 105 Smith Level Road, Chapel Hill, NC 27599, USA

³ Juniper Gardens Children's Project, University of Kansas, 444 Minnesota Ave., Kansas, KS 66101, USA

typically developing and developmentally delayed peers by the last half of the second year (Morgan et al. 2008; Richler et al. 2007; Watt et al. 2008; Wetherby et al. 2004). In prospective longitudinal infant studies, similar group differences extend to pre-diagnostic high-risk infant siblings of children with autism, though with subtler distinctions than for diagnosed older toddlers (Damiano et al. 2013; Loh et al. 2007; Ozonoff et al. 2008; Wolff et al. 2014). These findings of group differences paved the way for more nuanced explorations of RRB for toddlers with autism, including age associations within RRB sub-types and associations with developmental domains.

Repetitive Behavior in Toddlers with Autism

Much of the research on RRB in toddlers with ASD is based on data from general diagnostic assessments (Guthrie et al. 2013; Honey et al. 2008; Kim and Lord 2010; Moore and Goodson 2003; Richler et al. 2007, 2010). Other researchers have examined RRB among toddlers using researcher-developed observational protocols (Barber et al. 2012; Christensen et al. 2010; Damiano et al. 2013; Harrop et al. 2014; Loh et al. 2007; Morgan et al. 2008; Ozonoff et al. 2008; Watt et al. 2008). However, only one research group studied RRB in this population using a comprehensive parent report measure targeting a full range of RRB subtypes (Wolff et al. 2014). Parent report measures have the advantage of not requiring observational coding and are simple to administer. If found reliable in wider testing, parent report measures could be considered as a cost effective alternative for larger-scale research and for use by early intervention practitioners.

Age Associations and RRB Subtypes

Researchers have identified repetitive stereotyped movements (sometimes referred to as repetitive sensorimotor) and insistence on sameness as subcategories of RRB (Bishop et al. 2013; Lam et al. 2008; Richler et al. 2007, 2010; Turner 1999; Wetherby and Morgan 2007). Repetitive sensory motor RRB is of a lower order in that it occurs predominantly in earlier development; insistence on sameness, which occurs in later development, is of a higher order. Repetitive sensory motor, often has a motor component, such as repetitive body or object manipulations and motoric mannerisms while insistence on sameness, involves ritualistic behaviors and resistance to changes in routines (Cuccaro et al. 2003). These subtypes have been explored for toddlers with autism using large-sample data gathered from in-depth diagnostic interviews (Richler et al. 2007, 2010), moderate-sized samples from observational measures (Morgan et al. 2008; Watt et al. 2008), and a

small sample from a parent questionnaire (Wolff et al. 2014).

Richler et al. (2010) uncovered sharp contrasts when repetitive sensory motor and insistence on sameness were analyzed separately in toddlers, demonstrating the importance of discriminating between higher and lower order RRB subtypes when drawing conclusions about RRB in this age group. When RRB trajectories were studied from ages 2 to 3 and beyond using items from general diagnostic measures, they showed an overall diminishing pattern for toddlers with typical development, contrasting with unchanging levels of repetitive sensory motor and worsening levels of insistence on sameness for toddlers diagnosed with autism spectrum disorder (ASD; Kim and Lord 2010; Richler et al. 2010). A similar pattern held when RRB was studied prospectively from 12 to 24 months in children with and without later ASD diagnoses (Wolff et al. 2014).

Developmental Associations

Linkages between RRB and developmental indicators in toddlers with autism have been explored for four domains: social, communication, adaptive behavior, and cognition. The most investigated associations were between RRB and social functioning, with consistent findings of concurrent (Morgan et al. 2008; Watt et al. 2008; Wolff et al. 2014) and predictive (Richler et al. 2010) negative associations between RRB and social indicators during the toddler period. Two studies (Morgan et al. 2008; Watt et al. 2008) reported concurrent negative correlations between RRB and communication scores and one found a concurrent negative association between RRB and adaptive behavior (Wolff et al. 2014). Less convergence in concurrent findings was seen in studies of relationships between RRB and cognitive indicators in which no or little correspondence was found between the two (Kim and Lord 2010; Wolff et al. 2014); Richler et al. (2010) found a negative relationship of nonverbal IQ to repetitive sensory motor, but not to insistence on sameness at age 2. This insistence on sameness finding was consistent with that reported for 4- to 18-year-olds (Bishop et al. 2013). Findings related to predictive relationships of overall RRB to later cognitive outcomes varied, with no predictive association (Kim and Lord 2010), an association between repetitive behavior at 12 months and cognitive status at 36 months (Ozonoff et al. 2008), small correlations between lower order RRB in the second year and cognitive measures in the fourth year (Morgan et al. 2008; Watt et al. 2008), and high-non-verbal IQ 2-year-olds showing decreased lower forms of RRB over time and no predictive association between higher forms and cognitive ability (Richler et al. 2010).

To summarize, research on RRB and developmental associations found negative associations of RRB with social functioning (concurrent and predictive), communication (concurrent), and adaptive behavior (concurrent). Current and predictive negative associations with cognitive status were found with repetitive sensory motor but not insistence on sameness for toddlers with autism.

Outstanding Needs in RRB Toddler Research

Measurement systems used in toddler RRB studies fall into three general categories: observational coding systems designed for young children with communication delays, RRB items drawn from non-age-specific autism diagnostic measures, and a comprehensive non-age-specific RRB parent report questionnaire. Researchers in the first group coded and scored behavior samples from the Communication and Symbolic Behavior Scales (CSBS; Wetherby and Prizant 2002) or its companion tool, the Repetitive and Stereotyped Movement Scales (RSMS; Wetherby and Morgan 2007) to study repetitive sensory motor (Barber et al. 2012; Damiano et al. 2013; Morgan et al. 2008; Watt et al. 2008). These assessments permit closely focused analyses for young children with autism, but the considerable time and expertise required to train, code, and score observational data limits widespread use.

In the second group of studies, RRB items from autism diagnostic measures were reported for the Autism Observation Diagnostic Scale (ADOS; Lord et al. 2000), the autism diagnostic interview-revised (ADI-R; Kim and Lord 2010; Richler et al. 2007; Richler et al. 2010), and the Autism Observation Scale for Infants (AOSI; Loh et al. 2007). The ADI-R was the most commonly used instrument in this group. As it uses an intensive parent interview format, the ADI-R requires considerable time to administer. The ADOS was not designed as a comprehensive assessment of RRB and has relatively few items related to it and the AOSI, an instrument targeted to high-risk infants during the first year of life, was not designed for use with older toddlers.

Only one study has examined RRB using a less resource demanding parent report measure. Bodfish et al. (2000) used the Repetitive Behavior Scale-Revised (RBS-R) with 24-month-old toddlers with autism ($n = 36$), in addition to other groups. While not toddler specific, the RBS-R is a comprehensive subscale-differentiated questionnaire feasible for larger-scale research implementation. With older children, Bishop et al. (2013) conducted a factor analysis showing alignment of RBS-R subscales with repetitive sensory motor and insistence on sameness forms of RRB. The RBS-R has been found reliable for preschoolers with ASD (Mirenda et al. 2010); however, its reliability for toddlers has not been examined.

In addition to its cost effectiveness, if the RBS-R is determined reliable it has the added benefit of integrating parents' close knowledge of their toddlers into the assessment process in field-based practice. Current recommended practices for early intervention providers call for practitioners to work closely with families to gather assessment information in all areas of development and behavior (Division for Early Childhood 2014). In a family-centered model, such as that defined in Part C of IDEA ("Individuals with Disabilities Education Improvement Act, 20 U.S.C. § 1400" 2004), integration of families in the assessment process provides a natural link to their direct participation in intervention by strengthening their understanding and capacity to support their children's development.

Given the limited research on a comprehensive parent questionnaire format for assessing RRB in toddlers with autism, study of the RBS-R with a larger toddler sample could validate and extend findings derived from other measures that examined age and developmental associations for lower and higher order RRB. Further, given the RBS-R's use with older individuals with autism, comparison of toddler scores with those of older individuals could provide the field with a better understanding of RRB trajectories over time.

Purpose

This study addressed three questions pertinent to the development of RRB in toddlers with ASD. First, what is the internal consistency of the RBS-R total and subscale scores when used with toddlers? Second, are there associations among RBS-R total and subscale scores and concurrent measures of cognition, adaptive behavior, and social competence? Third, are there differences in the RBS-R total and subscale scores for younger and older toddler groups and how do any age-delineated toddler differences compare to subscale scores previously reported for older age groupings?

Method

Participants

Participants were recruited as part of a larger study, which was conducted at sites in Indiana, Kansas, and North Carolina. Participants included 143 toddlers ranging in age from 16 to 31 months. Eligibility criteria were: English-speaking family, birth weight >1500 g, absence of comorbid conditions (significant visual, hearing, or physical impairment; brain anomaly or injury; identified syndromes; or known genetic conditions), limited evidence of joint

attention (an early indicator associated with autism in toddlers and the focus of the ensuing JAML intervention), and findings indicating mild to severe range of concern on the ADOS-T, described below, when administered by fully trained personnel. Demographic and developmental characteristics are summarized in Table 1.

Measures

The primary measure for this analysis was the Repetitive Behavior Scale-Revised (RBS-R; Bodfish et al. 2000), which was used to assess repetitive and restrictive child behaviors. The RBS-R distributes 43-items among six subscales in a parent-completed questionnaire. A factor analysis identified five factors that align with the instrument’s subscales: Stereotyped Behavior, Compulsive Behavior, Self-Injurious Behavior, Ritualistic/Sameness Behavior (combination of the Ritualistic and Sameness subscales), and Restricted Interests (Lam and Aman 2007), for which the authors reported high internal consistency

(.78–.91) and good median inter-rater reliability at 67 % (ranging from 57 % for the Compulsive subscale to 73 % for the Stereotyped subscale) for the parent-completed administration format. It is the five subscales that we report here.

To establish that toddlers met our inclusion criteria, we used the autism diagnostic observation schedule-toddler version (ADOS-T; Lord et al. 2012). The ADOS-T is a recently released version of the ADOS targeted for use with toddlers and has shown superior sensitivity and specificity for differential diagnosis for this group when is compared to earlier ADOS versions. The ADOS-T also provides a measure of autism severity. Administering personnel were trained to the highest level of administration and scoring certification for research administration and were deemed reliable by the ADOS-T developers. The ADOS-T is a semi-structured assessment of social interaction, communication, play, and imaginative use of materials. We also used the ADOS-T to evaluate associations of its subscale scores with those of the RBS-R.

Several additional instruments were used to examine the association of developmental status with repetitive behavior. The Mullen Scales (1995) assess expressive and receptive language and cognitive functioning in children from birth to 68 months. The Mullen is a standardized measure with five assessment domains. The parent report version of the Vineland Adaptive Behavior Scales, Second Edition (VABS; Sparrow et al. 2005), which evaluates adaptive behavior from birth through adulthood, was used to report toddler functioning in the Communication, Socialization, and Adaptive Behavior domains.

Table 1 Demographic description

Participant characteristics (<i>n</i> = 143)	
% Male	82 %
Child age in months <i>M</i> (<i>SD</i>)	25.45 (4.00)
Race/ethnicity	
Asian	5 %
Black	13 %
Hispanic	9 %
White (non-Hispanic)	62 %
Other (including mixed)	10 %
Maternal education level	
High school diploma or less	17 %
Some college/No bachelor’s degree	37 %
4-year college degree	33 %
Graduate degree	13 %
Family income range	
\$0–\$23,050	22 %
\$23,051–\$49,999	22 %
\$50,000–\$74,999	37 %
>\$75,000	41 %
Mullen ELC <i>M</i> (<i>SD</i>)	56.50 (11.30)
Mullen NVDQ <i>M</i> (<i>SD</i>)	65.44 (18.85)
2.51 Vineland ABC <i>M</i> (<i>SD</i>)	74.30 (9.76)
Vineland social <i>M</i> (<i>SD</i>)	74.51 (9.75)
ADOS-T: Social Affective <i>M</i> (<i>SD</i>)	16.72 (3.37)
ADOS-T: RRB <i>M</i> (<i>SD</i>)	2.52 (1.71)

ELC Early Learning Composite, *NVDQ* nonverbal developmental quotient derived from the Mullen fine motor and visual perception subtests, *ABC* Adaptive Behavior Composite, *ADOS-T* autism diagnostic observational system-toddler version, *RRB* repetitive and restrictive behavior subtest

Results

RBS-R Reliability

To evaluate RBS-R reliability on the current sample, item level data were used to assess the internal consistency of the total (overall) score and subscale scores from the RBS-R. The rated scoring method uses a four-point Likert scale (i.e., a rating of 0–3 indicating the behavior’s occurrence and severity level) to create simple means of rated scores. Reliability was estimated as Cronbach’s alpha using SAS “proc corr” on all observations. Alphas fell within acceptable ranges across all subscales (Total: .92; Stereotyped: .74; Self-Injurious: .75; Compulsive: .79; Ritualistic/Sameness: .87; and Restricted: .79).

RBS-R Correlations with Developmental Indicators

Because the RRB data were not normally distributed in our sample, we used Spearman rank order correlation

coefficients to assess relationships between RBS-R scores and other variables. These variables included child age, the Mullen Early Learning Composite, and nonverbal developmental quotient scores (the latter derived from the Fine Motor and Visual Reception subscales), the VABS Adaptive Behavior Composite and Social Skills and Relationship subscales, and the ADOS-T RRB and Social-Affective subscales. As reported in Table 2, significant positive correlations (some weak) were found between age and three RBS-R scales, including Total ($r_s = .20, p < .02$), Compulsive ($r_s = .29, p < .001$) and Ritual/Sameness ($r_s = .17, p < .04$). These analyses suggest that children in this toddler cohort had somewhat higher overall RRB levels with increasing age, but for higher order and not lower order forms of RRB.

The associations of the RBS-R with cognitive and adaptive behavior measures were mixed. Mullen Early Learning Composite scores showed a weak negative correlation with the Stereotyped subscale ($r_s = -.21, p < .01$). We found a significant but weak negative correlation between Mullen nonverbal developmental quotient and RBS-R Stereotyped scores ($r_s = -.19, p < .02$) but no correlations with other RBS-R scores. The VABS Adaptive Behavior Composite scores showed negative correlations with the RBS-R total ($r_s = -.31, p < .01$), Stereotyped ($r_s = -.38, p < .001$), and Self-Injurious ($r_s = -.28, p < .001$) scores. Negative associations were also found between the VABS Social Skills and Relationship subscales subtest and the RBS-R Stereotyped ($r_s = -.30, p < .001$), Self-Injurious ($r_s = -.34, p < .001$), Compulsive ($r_s = -.19, p < .02$), Ritual/Sameness ($r_s = -.21, p < .01$), and Restricted ($r_s = -.17, p < .03$) scores.

Relationships between the RBS-R and the ADOS-T RRB and Social Affective subtests were also tested and reported in Table 2. Significant, though weak positive correlations were found between the ADOS-T RRB the

RBS-R Stereotyped subtest scores ($r_s = .19, p < .02$) and between the ADOS-T Social Affective and RBS-R Stereotyped subtest scores ($r_s = .21, p < .01$).

Comparison of RBS-R Scores Across Age Groups

Means and standard deviations for RBS-R totals and subscale scores were computed and reviewed. The Ritualistic and Sameness subscales were combined in accord with previous factor analysis (Lam and Aman 2007). We reported these scores separately for toddlers younger and older than 24 months for differential comparison to an analysis by Esbensen et al. (2009) who reported RBS-R scores for age groupings through adulthood.

Scores on the RBS-R for the current sample are reported in the first two rows of Table 3 followed by scores reported for older age groupings of individuals with autism previously reported by Esbensen et al. (2009). Increasing scores were reported from the under-25 to 25-and-older toddler age divisions. Of special interest were two subscales, Stereotyped and Ritualistic/Sameness, as lower and higher order forms of RRB, respectively. Table 3 shows a pattern of increasing Stereotyped subscale scores during the toddler period followed by a generally decreasing pattern through the lifespan. The pattern for the Ritualistic/Sameness subscale shows an increasing trend through the toddler period that continues to increase and then holds steady through the older childhood age periods before showing a decreasing trend in adulthood.

Discussion

The findings reported here enhance the emerging research on parent-reported repetitive behavior in toddlers with autism and confirm earlier findings (which used more

Table 2 RBS-R correlations with developmental indicators

Developmental indicator	RBS-R Scores											
	Total		Stereotypical		Self-injurious		Compulsive		Ritual/sameness		Restricted	
	<i>rho</i>	<i>p</i>	<i>rho</i>	<i>p</i>	<i>rho</i>	<i>p</i>	<i>rho</i>	<i>p</i>	<i>rho</i>	<i>p</i>	<i>rho</i>	<i>p</i>
Age	.20**	.02	.11	.19	.11	.19	.29***	<.001	.17*	.04	.11	.19
Mullen ELC	-.13	.10	-.21**	.01	-.10	.22	.005	.96	-.03	.73	-.03	.69
Mullen NVDQ	-.11	.20	-.19*	.02	-.10	.23	.07	.40	-.04	.64	.02	.77
Vineland ABC	-.31***	<.001	-.38***	<.001	-.28***	<.001	-.14	.09	-.15	.09	-.09	.30
Vineland Social	-.02	.85	-.30***	<.001	-.34***	<.001	-.19*	.02	-.21**	.01	-.17*	.03
ADOS-T (RRB)	.12	.14	.19*	.02	.10	.25	.0004	1.00	-.01	.90	.05	.54
ADOS-T (Social)	.08	.36	.21**	.01	.002	.98	.07	.38	-.03	.76	-.02	.85

ELC Early Learning Composite, NVDQ nonverbal developmental quotient derived from the Mullen fine motor and visual perception subtests, ABC Adaptive Behavior Composite, ADOS-T autism diagnostic observational system-toddler version

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 3 Repetitive and Restrictive Behavior Subscale Scores by age groups

Age group	<i>n</i>	Total Score	Stereotyped	Self-Injurious	Compulsive	Ritualistic/Sameness	Restricted Interest
16–24 months	61	19.98 (13.31)	.98 (.59)	.29 (.36)	.37 (.39)	.33 (.34)	.92 (.85)
25–31 months	82	27.06 (15.44)	1.16 (.66)	.43 (.48)	.69 (.60)	.45 (.41)	1.17 (.93)
2–4 years	74	30.92 (17.75)	.94 (.52)	.69 (.60)	.70 (.54)	.79 (.62)	1.11 (.82)
5–9 years	87	31.32 (20.06)	.97 (.63)	.44 (.57)	.70 (.62)	.88 (.70)	1.43 (.87)
10–13 years	80	28.82 (17.68)	.92 (.62)	.51 (.51)	.66 (.63)	.76 (.58)	1.15 (.90)
14–21 years	220	26.91 (19.25)	.73 (.64)	.46 (.53)	.63 (.66)	.79 (.63)	1.17 (.93)
22–30 years	122	23.98 (16.58)	.59 (.54)	.43 (.44)	.61 (.57)	.73 (.63)	.95 (.87)
31–40 years	77	21.60 (12.73)	.56 (.42)	.46 (.46)	.55 (.50)	.65 (.60)	.64 (.65)
41–50 years	41	21.02 (17.65)	.57 (.51)	.37 (.38)	.60 (.60)	.62 (.57)	.67 (.79)
51+ years	11	14.91 (8.55)	.33 (.19)	.18 (.16)	.52 (.50)	.45 (.39)	.67 (.92)

Scores in italics were previously reported by Esbensen et al. (2009) and are presented here for comparison

resource-intensive measurement systems) on its relation to other developmental domains and its pattern of change over time. We found the Repetitive Behavior Scale-Revised (RBS-R) to be reliable when applied to toddlers with autism with acceptable internal consistency across subscales, although with a stronger alpha for the total score than for individual subscales, which had fewer items. This finding is in line with research confirming the utility and internal consistency of the instrument for preschoolers (Mirenda et al. 2010) and individuals across the lifespan (Lam and Aman 2007).

Associations with Developmental Indicators

The associations we found between repetitive/restrictive behavior (RRB) and developmental indicators for toddlers with autism using a parent report measure largely align with others' findings that were based largely on more time- and resource-intensive measures. Scores on the Stereotypic subscale of the RBS-R are of greatest interest for our toddler sample since it represents a lower order form of RRB more commonly observable in younger children (Bishop et al. 2006). The strongest negative association between scores on the RBS-R Stereotypic subscale and other developmental domains was with adaptive behavior, a finding congruent with Wolff et al. (2014), who also based their findings on the RBS-R. This strong association could be explained in part by the fact that both the RBS-R and VABS adaptive behavior measures were based on parent report. It is possible that parents rated consistently across the two instruments (i.e., individually tended toward either higher or lower ratings on both). However, similar findings by other researchers investigating social and RRB associations for toddlers with autism who used different instrumentation that was not reliant on parent report reduce this concern (Morgan et al. 2008; Watt et al. 2008). Also, similar to others (Kim and Lord 2010; Morgan et al. 2008; Richler et al. 2010; Watt et al. 2008; Wolff et al. 2014), our

finding of a negative association between RRB and cognition was less robust than its association with other developmental domains.

It is noteworthy that these findings on developmental associations with RRB, which were based on the RBS-R parent report measure, replicate earlier toddler findings that relied on different RRB measures, including the ADI-R parent interview (e.g., Richler et al. 2010), the ADOS (e.g., Kim and Lord 2010), and researcher-developed observational coding measures (e.g., Morgan et al. 2008). We also replicated findings of the only other study to use the RBS-R to assess toddlers with autism, conducted by Wolff et al. (2014), which was based on a small sample. This convergence of findings provides increased confidence in the conclusion that higher levels of repetitive behavior in toddlers with autism are associated with poorer concurrent social and adaptive behavior status. However, it is important to keep in mind that we cannot infer that this association is either deterministic for individuals (i.e., applicable to all individuals) or causative in either direction.

Scores from the RBS-R showed a weak positive relationship to Stereotypical scores from the diagnostic measure recently adapted for toddlers, the ADOS-T. This weak association was observed for both the RRB and social subcomponents of the ADOS-T. We did not find any correspondence between the ADOS-T and any other RBS-R subscales. This finding is understandable in that the diagnostic purpose of the ADOS-T calls for a measurement system aimed at identifying autism in toddlers rather than measuring the level of RRB or differentiating among RRB characteristics.

In sum, we can infer from the negative relationship between repetitive behavior and other developmental indicators a tendency for less repetitive behavior in toddlers with autism to occur with higher developmental status and the reverse scenario for higher levels of repetitive behavior. However, this association was stronger with social and adaptive behavior than it was with cognitive status.

Repetitive and Restrictive Behavior Differences and Age Trends

Disparities in others' findings between repetitive sensory motor (lower order RRB) and insistence on sameness (higher order) for toddlers' developmental associations with RRB (Kim and Lord 2010; Richler et al. 2010) were largely upheld in our findings, with stronger RRB and developmental associations for the Stereotyped than other subscales. Also, as shown in Table 3, when toddler RBS-R scores are compared to those of older individuals, toddler scores are generally higher for the Stereotyped and lower for the other subscales, especially the Ritualistic/Sameness subscale, which may be the best RBS-R measure of insistence on sameness (Bishop et al. 2006). (The absolute scores are not comparable as the upper limit of possible scores varies among subscales.) This disparity across lower and higher order RRB forms is expected based on the lower prevalence of insistence on sameness than of repetitive sensory motor at earlier ages (Bishop et al. 2006).

In our analysis of RBS-R scores of younger compared to older toddlers, we observed a pattern of increasing (worsening) scores with toddler age, a pattern also found by others using different RRB measures (Guthrie et al. 2013; Richler et al. 2010). When viewed against RBS-R scores for older age groups previously reported by Esbensen et al. (2009), this pattern showed a continued increasing trend over time for all subscales before peaking and beginning a decreasing pattern during later childhood with, as might be expected for the lower order form of RRB, earlier peaking for the Stereotyped (repetitive sensory motor) than for the Ritualistic/Sameness (insistence on sameness) subscales. In spite of the greater predominance of stereotypical behavior for toddlers, the trend of increasing RBS-R scores for toddlers with autism from early to later toddlerhood occurred across all RBS-R subscales, indicating the beginning emergence across the full RRB spectrum during the early childhood period.

Implications

An important implication from our findings is that a comprehensive parent report-based instrument can be both cost effective and reliable as a means of assessing RRB in toddlers with autism, producing results that align with findings from more time-intensive observational or interview-based measures. This adds to the RBS-R's feasibility and validity for more widespread use in situations in which an efficient measure is needed, such as in large research studies or for practitioner use in evaluating RRB change over time.

This study is an important extension of findings reported by Wolff et al. (2014), who described RBS-R results for a

small sample of toddlers with autism generated from an infant sibling study in which parents' previous experience having a child with autism may have influenced their ratings. The current study had a large ethnically diverse sample with a wider range of toddler developmental functioning but reported findings similar to Wolff and colleagues'. The ethnic diversity reflected in our sample is important in that toddlers and families from non-majority backgrounds are likely to be under-represented in research due to differential patterns of identification that favor families who have more economic resources, are more highly educated, and who are white (Travers et al. 2014).

The findings from our large and diverse sample, together with their general congruence with research findings based on more resource intensive measurement processes, add credence to the viability of the RBS-R for assessing RRB in toddlers.

Limitations

A few considerations should be taken into account in interpreting our findings. First, a small number of items on the RBS-R (e.g., in the Compulsive subscale) are not as appropriate for toddlers as for older children. Parents may be more responsive to questions specifically oriented toward typical toddler experience and less responsive to those that they may consider less relevant. A second consideration, while not necessarily a limitation, is that our sample excluded children with evidence of joint attention according to our strict definition of exchanged looks between a partner and object while showing evidence of social, rather than instrumental, interest in the interaction. The reason for this exclusion was because joint attention was the primary target of the intervention for the larger study from which the RRB data were collected. As such, our sample may not be fully representative of the entire population of toddlers who might receive an autism diagnosis (i.e., it might be a somewhat lower functioning sample) because, even though joint attention is a unique area of difficulty for toddlers with autism, it is sometimes defined in less strict terms than by our criteria. Finally, although we drew data from a large sample, our findings should be considered preliminary since ours is only the second study of RRB in toddlers with autism using the RBS-R, albeit the first with a large sample.

Conclusion

This study of 143 toddlers with autism used a cost-effective comprehensive parent report measure to substantiate emerging findings that repetitive behavior in toddlers with autism is negatively associated with adaptive behavior and

social indicators, is minimally associated with cognitive indicators, and shows a trend towards increasing with age during the toddler period in higher order forms of RRB. The RBS-R was found to have an adequate level of internal consistency when used for our toddler population.

Acknowledgments This project was supported by a grant from The Institute for Education Sciences, U.S. Department of Education #R324A120291.

Author Contributions HHS directed the larger three-site study of which the current study was a part, designed the current study, conducted preliminary statistical analysis, and drafted the manuscript; SLO oversaw data analysis for the larger study, led site activities, conceived the initial focus for the current study, and provided conceptual input. KMB led site activities, oversaw assessment activities for the larger study, and provided conceptual input. JHS participated in the design of the study and performed the statistical analysis. All authors read and approved the final manuscript.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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