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The Repetitive Behavior Scale-Revised: Independent Validation in Individuals with Autism Spectrum Disorders

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Abstract A key feature of autism is restricted repetitive behavior (RRB). Despite the significance of RRBs, little is known about their phenomenology, assessment, and treatment. The Repetitive Behavior Scale-Revised (RBS-R) is a recently-developed questionnaire that captures the breadth of RRB in autism. To validate the RBS-R in an independent sample, we conducted a survey within the South Carolina Autism Society. A total of 320 caregivers (32%) responded. Factor analysis produced a five-factor solution that was clinically meaningful and statistically sound. The factors were labeled ''Ritualistic/Sameness Behavior,'' ''Stereotypic Behavior,'' ''Self-injurious Behavior,'' ''Compulsive Behavior,'' and ''Restricted Interests.'' Measures of internal consistency were high for this solution, and interrater reliability data suggested that the RBS-R performs well in outpatient settings.

Keywords Autism · Repetitive behavior · Stereotypies · Assessment · Rating scale

Introduction

In recent years, much of the work on the features of autism has focused on core social and communication deficits of the disorder, rather on restricted and repetitive behavior, which is also a core feature (Lewis & Bodfish, 1998; Rutter, 1996). In the Diagnostic and Statistical Manual of Mental Disorders–4th Edition (DSM-IV), this third characteristic of autistic disorder is described as ''restricted, repetitive and stereotyped patterns of behavior, interests, and activities'' (American Psychiatric Association, 1994). DSM-IV criteria include the following: (a) stereotyped or restricted patterns of interest abnormal in intensity or focus; (b) inflexible adherence to nonfunctional routines or rituals; (c) stereotyped and repetitive motor mannerisms; and (d) preoccupation with parts of objects (American Psychiatric Association, 1994). Common to these behaviors are their repetition, invariance, and inappropriateness.

Restricted repetitive behaviors (RRBs) may cause significant impairment to individuals with autism spectrum disorders (ASDs) (Gordon, 2000). These rituals can consume the majority of waking hours of an individual and interfere with daily family activities. Affected individuals may become anxious, agitated, or disruptive if such behaviors are interrupted (Gordon, 2000). These behaviors can be socially inappropriate and stigmatizing. RRBs have also been shown to interfere with observational learning (Varni, Lovaas, Koegel, & Everett, 1979), attempts to teach play skills (Koegel, Firestone, Kramme, & Dunlap, 1974), responses to auditory stimuli (Lovaas, Littownik, & Mann, 1971), performance of discrimination tasks (Koegel & Covert, 1972), and environmental exploration (Pierce & Courchesne, 2001).

Researchers have recently begun to examine the specificity of repetitive behaviors in autism and how (or if) they differ from other disorders (Bodfish,

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Symons, Parker, & Lewis, 2000; McDougle et al., 1995). If certain types or patterns of RRB *are* found to be specific to autism, such knowledge could guide research to the neurobiological underpinnings of the disorder as these behaviors may be the end result of very different brain regions or systems (Militerni, Bravaccio, Falco, Fico, & Palermo, 2002). Repetitive behaviors show significant variability across individuals, and there are few data to indicate their stability over time (Cuccaro et al., 2003). This heterogeneity in expression of RRBs may prove to be a useful tool in identifying potential subtypes of ASDs.

To date, workers in the field have not focused on any particular assessment tool. A variety of instruments have been used to measure aspects of repetitive behavior. Examples include tools for assessing (a) stereotypy using the Timed Stereotypy Rating Scale (Campbell et al., 1990), (b) obsessions and compulsions using the Yale-Brown Obsessive-Compulsive Scale and (Y-BOCS; Goodman et al., 1989; McDougle et al., 1995; Scahill et al., 1997), and (c) sameness behavior using the Sameness Questionnaire (Prior & MacMillan, 1973)]. The *Children's* Yale-Brown Obsessive Compulsive Scale (CY-BOCS; which is a developmentally-revised version of the Y-BOCS intended for use in young people) has been employed recently in various pharmacological studies (Research Units on Pediatric Psychopharmacology Autism Network, 2002) despite the fact that it was originally intended for the assessment of obsessive compulsive disorder in typically-developing children. Due to the communication limitations in autism, usually the compulsion section of the CY-BOCS is used without the obsessions section in this population. The CY-BOCS provides an overall severity score, and does not distinguish between types of RRB (Scahill et al., in press).

Recently, Bodfish et al. (2000) refined an informant-based scale, called the Repetitive Behavior Scale (RBS), to create the *Repetitive Behavior Scale-Revised* (*RBS-R*). The *RBS-R* is intended to assess the variety of RRBs observed in individuals with ASDs. The original RBS (Bodfish, Symons, & Lewis, 1999) had three subscales: (a) Stereotypic Behavior, (b) Self-injurious Behavior, and (c) Compulsions. The RBS was administered via a mailing survey to the Autism Society of North Carolina, and results from 498 respondents (aged between 2 years and 18 years) indicated good total score inter-rater reliability ($r = 0.88$) and test–retest reliability ($r = 0.71$) However, feedback from parents and clinicians suggested that the RBS did not tap into more complex RRBs observed in people with autism (Bodfish, personal communication, March 2004). Therefore, Bodfish and colleagues expanded the original RBS to include more complex RRBs by adding items assessing ritualized behaviors, insistence on sameness, and restricted interests. In addition to items from the original RBS, Bodfish et al. (1999) adapted items from the Autism Diagnostic Interview-Revised (Lord, Rutter, & Le Couteur, 1994), the Childhood Routines Inventory (Evans et al., 1997), the Sameness Questionnaire (Prior & MacMillan, 1973), and the Abnormal Focused Affections Checklist (Schultz & Berkson, 1995). This resulted in the current 43-item *RBS-R*. Items are rated on a four-point Likert scale ranging from (0) ''behavior does not occur'' to (3) ''behavior occurs and is a severe problem,'' and raters are asked to refer to the previous month when completing the scale.

The items of the *RBS-R* have been *conceptually grouped* (i.e., based on clinical experience) into six subscales. These include: (a) Stereotyped Behavior (movements with no obvious purpose that are repeated in a similar manner); (b) Self-injurious Behavior (actions that cause or have the potential to cause redness, bruising, or other injury to the body); (c) Compulsive Behavior (behavior that is repeated and performed according to a rule or involves things being done ''just so''); (d) Ritualistic Behavior (performing activities of daily living in a similar manner); (e) Sameness Behavior (resistance to change, insisting that things stay the same); and (f) Restricted Behavior (limited range of focus, interest, or activity). Bodfish et al. conducted a principal components analysis on a sample of 124 RBS-R ratings completed by caregivers of individuals with autism in the Autism Society of North Carolina. Findings of these analyses suggested the presence of six components (Bodfish & Lewis, 2002). However, some items did not load most heavily on their hypothesized subscales. The principal components analysis was used to support the assumption that there is considerable variation within the domain of RRBs, but it did not determine item assignment to subscales. Subscale interrater reliability ranged from 0.55 (Sameness Behavior) to 0.78 (Self-injurious Behavior), and test–retest data ranged from 0.52 (Ritualistic Behavior) to 0.96 (Restricted Interests) (Bodfish & Lewis, 2002).

Thus, the RBS-R appears promising in its ability to assess a variety of RRBs. However, Bodfish and Lewis' (2002) principal components analysis was based on a sample of 124 subjects, which is small for a scale with 43 items. Further, this analysis was not used to determine the assignment of items to subscales. Therefore, it is important to examine how the current six subscales of the RBS-R compare to latent variables revealed by

independent factor analysis with an adequate sample size.

The primary objective of this study was empirically to determine the subscale structure of the RBS-R using factor analysis in a new sample of individuals with ASDs. It was hypothesized that the six-factor structure of the RBS-R would be confirmed via exploratory factor analysis. Second, we also wanted to assess the internal consistency of the derived subscales and to look at interrater reliability. Third, we wanted to develop preliminary norms for the subscales derived in our factor analysis.

Method

Participants

The participants in the factor analytic study of the RBS-R were individuals with ASDs whose parents or caregivers were members of the South Carolina Autism Society (SCAS). The Autism Society of America and their numerous state chapters have become one of the leading sources of information and referral for individuals with autism. Such state chapters often represent a broad and diverse sampling of individuals with autism and their families. At the time of this survey, the SCAS had a mailing list for parents and caregivers of people with autism that totaled 1,245 individuals.

In addition to the factor analytic study, interrater reliability ratings were obtained from pairs of caregivers of individuals with ASDs. Subjects residing in the community were recruited from the psychopharmacological research database at the Nisonger Center (Ohio State University) and through the Autism Society of Ohio. Subjects living in a residential setting were recruited from the J. Iverson Riddle Center in Western North Carolina.

Instrument

The previously described 43-item RBS-R was used for this study. In addition, an all-encompassing summary score (called the Global Severity Score) was added to the end of the scale, where participants were asked to rate, globally, how much of a problem these repetitive behaviors were on a scale ranging from 1 to 100 (where 1 = *not a problem at all*, and 100 = *as bad as you can imagine*). In addition to *severity*, raters were asked to weigh in the extent to which the repetitive behaviors were a problem ''both for the person with autism *and* the people around him or her.'' Raters could assign any Global Severity score, irrespective of scores used for the 43 items, allowing raters to give greater emphasis to any domain of concern.

Procedures

Prior to starting the survey, approval was obtained from Ohio State University's Institutional Review Board, as well as from the SCAS and the J. Iverson Riddle Developmental Center. The president of the Ohio Autism Society also agreed to distribute information about the survey via the Ohio ASA membership listserv.

For the main factor analytic study, 1,245 mailings were assembled in stamped, sealed envelopes and then sent to the SCAS, where staff members affixed mailing labels and sent them to their parent mailing list. Each mailing included the following: (a) a personally signed cover letter, (b) the questionnaire, (c) three dollars in cash, and (d) a business reply envelope. Among other things, the cover letter explained the purpose of the study, the advantages of obtaining a high response rate, an assurance that the main results of the study would appear in the SCAS's newsletter, and the fact that all results were anonymous. In addition, the mailing contained an insert on brightly-colored paper asking professionals or individuals *who were not caregivers of an individual with autism spectrum disorder* to return the blank questionnaire to us with either ''professional'' or ''no autism'' written at the top.

For the smaller inter-rater reliability study, a total of 74 mailings were sent to parents and/or caregivers of individuals with autism. 30 of these were sent to parents in the Nisonger Center's psychopharmacology research database, 25 to people who responded to the information posted on the Ohio Autism Society's listserv, and 19 to direct care staff working at the J. Iverson Riddle Center. Each mailing contained: (a) two questionnaires; (b) a signed cover letter explaining the study, the importance that raters fill out the forms independently, and an assurance of confidentiality; and (c) a business reply envelope. The questionnaires asked for the subject's sex, age, the rater's relationship to the person with autism, and the length of that relationship.

Results

Response Rate for the SCAS

Of the 1,245 mailings sent to the parent mailing list of the SCAS, 113 were returned as invalid addresses

(resulting in 1,132 distributed mailings). The total number of responses from this mailing equaled 361. Twenty-eight respondents reported that the person they cared for did not have autism. Another nine respondents reported that they were professionals in the field of autism (but not a primary caregiver). Three respondents received more than one survey and returned the duplicates. Another subject was reported as deceased. If this combined number (41) is extrapolated over the entire target sample (to determine what proportion of nonresponders probably did not have autism, were professionals, received more than one survey, or were deceased), this suggests that a total of 129 subjects should be subtracted from the total, leaving an effective target sample size of 1,003. As 320 ratings from caregivers of individuals with autism were returned, this indicates a true response rate of 32%.

Of these 320 responses, 13 were excluded from subsequent analyses due to greater than 7% of missing data on the RBS-R items (3 or more items out of 43 missing). This resulted in a final sample size of 307 participants.

Participant Characteristics

The characteristics of the 307 people rated in the SCAS sample are listed in Table 1. Age ranged from 3 years to 48 years with a mean of 15.34 (SD = 9.60; median = 13.0). There were 253 males (82.4%) and 52 females (16.9%). The majority of the sample was Caucasian, though a sizable minority (23.1%) was African American. The large majority of the participants reported a diagnosis of autism (81.4%), whereas only 4.6% did not know the individual's specific diagnosis within the pervasive developmental disorders (Table 1). Severity of ASD was fairly equally divided among the three levels provided. Educational placement showed that only a minority (16.6%) were able to attend regular classes, with 57.7% assigned to special classes, 14.7% to special schools, and 9.4% receiving other forms of education.

Table 1 Demographic characteristics of respondents from the South Carolina Autism Society

	Number	Percentage
Age (*missing = 8*)		
0–5 years	33	10.3
6–12 years	113	36.3
13–20 years	88	29.7
21 years and older	65	22.2
Sex (male/female) (*missing = 2*)	253/52	82.4/16.9
Race (*missing = 4*)		
Caucasian	212	69.1
African American	71	23.1
Asian	8	2.6
Hispanic	4	1.3
Other	8	2.6
Reported diagnosis (*missing = 4*)		
Autistic disorder	250	81.4
Asperger's syndrome	20	6.5
PDD-NOS	19	6.2
Do not know	14	4.6
Severity of autism spectrum disorder (*missing = 4*)		
Mild	104	33.9
Moderate	119	38.8
Severe	63	20.5
Do not know	17	5.5
School placement (*missing = 5*)		
Regular class in a regular school	51	16.6
Special class in a regular school	177	57.7
Special school	45	14.7
Other (e.g., homeschooled)	29	9.4

Factor Analysis of the RBS-R

Before conducting an exploratory factor analysis, the rate of item endorsement was examined to see if there were any items that should be dropped from the analysis based on either too low (less than 10% of the sample) or too high (over 90% of the sample) relative frequency. The rate of endorsement was calculated on the basis of dichotomous (present/not present) data, which were created by collapsing severity ratings 1 through 3. None of the items were eliminated; the frequency of endorsement ranged from 17.3% (item 13: ''Inserts finger or object: eye poking, ear poking'') to 80.4% (item 6: ''Sensory: covers eyes, looks closely or gazes ....''). The rates of endorsement (or item prevalence) for all items can be found in Table 2.

We then conducted an exploratory factor analysis using the inter-item correlation matrix from the 43 items of the RBS-R. Our decision to use an exploratory (rather than confirmatory) approach was based on the fact that the original item assignment of the RBS-R was conceptually determined rather than by empirically driven factor analytic techniques. We used the Ordinary Least Squares (OLS, otherwise known as iterative principal factors) discrepancy function in CEFA (Comprehensive Exploratory Factor Analysis) with oblique quartimax rotation. Oblique rotation was used because it seemed likely that the constructs comprising repetitive behavior in this population would be correlated. Fabriger, Wegener, MacCallum, and Strahan (1999) noted that other advantages of oblique rotation (over orthogonal rotation) include better simple structure and provision of estimates of correlation among common factors. These advantages have led many researchers to favor oblique rotation when assessing human traits that are likely to be

Table 2 Five-factor solution using ordinary least squares extraction with oblique quartimax rotation

Original item assignment	Freq. of endorse.	%	Factor I	Factor II	Factor III	Factor IV	Factor V
Stereotypy subscale							
1. Body movements	140	45.8	0.125	0.116	**0.470**	0.036	–0.286
2. Head movements	117	38.2	0.105	0.073	**0.512**	0.023	–0.134
3. Finger movements	227	74.2	0.043	0.057	**0.651**	–0.004	–0.086
4. Locomotion	162	52.9	–0.037	0.113	**0.566**	0.048	0.072
5. Object usage	168	54.9	–0.023	0.182	**0.628**	–0.060	0.168
6. Sensory	246	80.4	0.053	0.178	**0.492**	0.022	0.100
Self-injurious subscale							
7. Hits w/body	126	41.2	–0.007	**0.666**	0.143	0.008	–0.028
8. Hits against surface	92	30.1	0.044	**0.551**	0.169	–0.034	0.055
9. Hits w/object	63	20.6	0.014	**0.703**	0.070	–0.015	0.029
10.Bites self	87	28.4	0.088	**0.506**	0.129	–0.142	–0.026
11. Pulls hair/skin	72	23.5	0.123	**0.623**	–0.053	0.051	–0.052
12. Rubs/scratches	100	32.7	–0.002	**0.683**	–0.018	0.040	0.033
13. Inserts finger/object	53	17.3	–0.003	**0.511**	0.086	0.057	–0.025
14. Picks skin	102	33.3	0.030	**0.570**	–0.260	0.152	–0.050
Compulsive subscale							
15. Ordering	220	71.9	0.023	–0.062	–0.032	**0.729**	0.045
16. Completeness	202	66	–0.114	0.174	0.111	**0.545**	0.125
17. Washing	112	36.6	–0.066	0.165	0.015	**0.553**	–0.026
18. Checking	79	25.8	0.084	0.096	0.077	**0.577**	–0.197
19. Counting	98	32	–0.049	0.105	0.056	**0.521**	0.135
20. Hoarding	145	47.4	0.080	0.135	–0.078	**0.466**	0.119
21. *Repeating*	173	56.5	*0.351*	*0.018*	*0.13*	*0.275*	*0.101*
22. Needs to touch/tap	176	57.5	0.147	0.040	**0.351**	0.110	0.116
Ritualistic Subscale							
23. *Eating/mealtime*	200	65.4	*0.333*	*–0.108*	*0.124*	*0.251*	*0.094*
24. *Sleeping/bedtime*	186	60.8	*0.319*	*–0.044*	*0.012*	*0.363*	*0.176*
25. *Self care routine*	160	52.3	*0.427*	*–0.066*	*–0.002*	*0.410*	*0.036*
26. Transportation routine	164	53.6	**0.479**	–0.057	0.112	0.286	0.023
27. Play/leisure routine	170	55.5	**0.511**	–0.028	0.077	0.180	0.161
28. Communication	189	61.8	**0.373**	0.063	–0.234	0.096	0.244
Sameness Subscale							
29. *Placement of objects*	191	62.4	*0.412*	*0.006*	*–0.015*	*0.453*	*0.020*
30. No new places	149	48.7	**0.712**	0.002	0.000	–0.057	–0.081
31. No interruption	245	80.1	**0.573**	0.132	–0.013	0.078	0.130
32. Walks certain way	97	31.7	**0.566**	0.093	0.199	0.044	–0.184
33. Sits certain place	159	52	**0.631**	–0.032	0.201	0.114	–0.172
34. Appearance/behavior of others	146	47.7	**0.526**	0.114	0.104	0.088	0.010
35. Uses certain door	84	27.5	**0.477**	–0.017	0.235	0.07	–0.018
36. Videotapes	218	71.2	0.297	0.003	–0.001	0.025	**0.492**
37. Difficult transitions	234	76.5	**0.740**	0.06	–0.018	–0.133	0.184
38. Insists on routine	211	69	**0.780**	0.081	–0.014	–0.011	0.076
39. Insists on time	170	55.5	**0.770**	0.089	–0.087	0.031	0.076
Restricted Subscale							
40. Preoccupation with subject	232	75.8	0.138	0.017	0.078	0.082	**0.646**
41. Attached to object	198	64.7	0.127	0.058	0.313	0.135	**0.446**
42. Preoccupied with part of object	145	47.4	0.079	0.014	**0.444**	0.142	0.338
43. Preoccupation with movement	141	46.1	0.027	0.015	**0.458**	0.168	0.292

Note: Bold font indicates the factor on which each item loaded most heavily and corresponds to the subscale scoring that the present authors recommend. Items and numerals in italics failed to load with any single factor

correlated with one another (Costello & Osborne, 2005; Fabriger et al., 1999; Floyd & Widamin, 1995).

The number of factors to retain was guided by: (a) the scree plot method (Cattell, 1966), (b) eigenvalues above 1.0, (c) goodness-of-fit as estimated by Root Mean Square Error of Approximation (RMSEA; Browne & Cudeck, 1992), and (d) interpretability. Solutions between two and six-factors were evaluated using these criteria. Items were adopted as loading on a given factor if (a) they loaded 0.35 or higher on that factor and (b) this loading was at least 0.10 higher than the loading on any other factor. Examination of the factor solutions indicated that either a four- or five-factor solution could be adopted. Ultimately, we

selected the five-factor solution, primarily due to the addition of the fifth factor (Restricted Interests), which we thought has clinical significance for individuals with autism. The RMSEA point estimate for this five-factor solution was 0.061, which is considered a reasonable fit (Browne & Cudeck, 1992).

This five-factor solution is presented in Table 2; we named these factors: (I) ''Rituals/Sameness,'' (II) ''Self-injurious Behavior,'' (III) ''Stereotypic Behavior,'' (IV) ''Compulsive Behavior,'' and (V) ''Restricted Interests.'' This solution has a simple structure in that the high factor loadings were high and the other loadings were low. However, five items (item (21 ''repeating,'' (23 ''eating/mealtime rituals,'' (24 ''sleeping/bedtime rituals,'' (25 ''self care rituals,'' and (29 ''insists that things remain in the same place'') did not load differentially enough on one-factor to be retained. The mean factor loadings for factors I through V were 0.55, 0.60, 0.51, 0.53, and 0.53, respectively. Collectively, the five-factors accounted for approximately 47.5% of the variance. Table 3 shows the correlations among factors; it shows the highest correlation between Factors I (Rituals/Sameness Behavior) and IV (Compulsive Behavior).

Item-total Correlations

From this point on, these groupings of items (factors) will be referred to as subscales. Subscale scores were calculated by taking the integer weightings (0–3) scored by the caregivers and totaling them for all items in the subscale. As a way of validating the five-factor structure, item-total correlations were calculated. Each of the remaining 38 items on the RBS-R was correlated with the subscale scores (item-deleted) of Ritualistic/Sameness Behavior, Self-injurious Behavior, Stereotypic Behavior, Compulsive Behavior, and Restricted Interests. All items correlated most highly with their hypothesized subscale (Table 4).

The mean item-total correlation for Ritualistic/Sameness Behavior was 0.65 (SD = 0.09, range from 0.42 to 0.78); for Self-injurious Behavior, 0.58 (SD = 0.09, range from 0.42 to 0.70); for Stereotypic Behavior, 0.57 (SD = 0.06, range from 0.48 to 0.65); for Compulsive Behavior, 0.54 (SD = 0.04, range from 0.51 to 0.62); and for Restricted Interests, 0.61 (SD = 0.09, range from 0.52 to 0.70).

Internal Consistency

Cronbach's alpha was used to measure internal consistency, which is the extent to which an item is correlated with the remaining items from its subscale. The alpha values for the five subscales, listed in Table 5, ranged from 0.78 (Restricted Interests) to 0.91 (Ritualistic/Sameness Behavior). All values are within or above the acceptable range for research purposes (Nunnally, 1967); alphas over 0.80 are generally considered moderately high-to-high.

Global Severity Score

The Global Severity Score (where respondents globally rated how much of a problem these repetitive behaviors were, from 1 to 100) was significantly correlated with the Total Score (sum of all of the subscale scores) on the RBS-R (Spearman correlation coefficient = 0.70, $P < .001$). Correlations between the Global Severity Score, Total Score, and all subscale scores can be found in Table 6. Although these correlations were all significant at the $P < .001$ level, the Global Score was not as well correlated with subscale scores as the Total Score.

Interrater Reliability

Interrater reliability was calculated using intraclass correlation coefficients (ICC) with a one-way random effects model (Shuck, 2004). The first sample ($n = 28$) was recruited from the Nisonger Center's psychopharmacology research database ($n = 18$) and the Ohio Autism Society's listserv ($n = 10$). All questionnaires were completed by parents or primary caregivers. The participants rated in this sample were between 3 years and 20 years of age (mean = 9.8, SD = 4.9). Interrater reliability for subscales ranged from 0.57 (Compulsive Behavior) to 0.73 (Stereotypic Behavior) (median reliability = 0.67). These values are presented in Table 5; all subscales met fair to good levels of clinical

Table 3 Interfactor correlations

	Ritualistic/Sameness (I)	Self–injurious (II)	Stereotypic (III)	Compulsive (IV)
Ritualistic/Sameness (I)	–	–	–	–
Self–injurious (II)	0.38	–	–	–
Stereotypic (III)	0.35	0.48	–	–
Compulsive (IV)	0.55	0.28	0.29	–
Restricted Interests (V)	0.38	0.14	0.18	0.31

Table 4 Corrected item–total correlations for five–factor solution of RBS-R items

	Rituals/Sameness	SIB	Stereotypy	Compulsive	Restricted Interests
Stereotypy subscale					
Body movements	0.25	0.35	0.48	0.21	0.09
Head movements	0.29	0.33	0.51	0.25	0.26
Finger movements	0.30	0.36	0.62	0.23	0.24
Locomotion	0.29	0.37	0.59	0.28	0.29
Object usage	0.35	0.46	0.65	0.27	0.37
Sensory	0.38	0.44	0.60	0.33	0.37
Needs to touch/tap	0.40	0.31	0.48	0.37	0.40
Preoccupied with part of object	0.50	0.34	0.60	0.43	0.53
Preoccupated with movement	0.45	0.34	0.58	0.42	0.47
Self–injurious subscale					
Hits w/body	0.32	0.68	0.49	0.22	0.22
Hits against surface	0.35	0.59	0.48	0.27	0.27
Hits w/object	0.35	0.70	0.45	0.26	0.26
Bites self	0.26	0.51	0.37	0.15	0.15
Pulls hair/skin	0.38	0.59	0.37	0.25	0.25
Rubs/scratches	0.33	0.64	0.42	0.25	0.25
Inserts finger/object	0.29	0.51	0.39	0.19	0.19
Picks skin	0.25	0.42	0.16	0.12	0.12
Compulsive subscale					
Ordering	0.44	0.15	0.27	0.62	0.34
Completeness	0.39	0.36	0.42	0.54	0.36
Washing	0.33	0.29	0.31	0.52	0.28
Checking	0.43	0.30	0.33	0.53	0.23
Counting	0.40	0.28	0.35	0.52	0.36
Hoarding	0.43	0.27	0.30	0.51	0.42
Ritualistic/sameness subscale					
Transportation routine	0.65	0.29	0.41	0.52	0.43
Play/leisure routine	0.67	0.30	0.41	0.49	0.52
Communication	0.42	0.16	0.14	0.30	0.39
No new places	0.60	0.25	0.32	0.31	0.33
No interruption	0.70	0.38	0.41	0.47	0.49
Walks certain way	0.61	0.41	0.46	0.38	0.32
Sits certain place	0.68	0.33	0.45	0.42	0.37
Appearance/behavior of others	0.65	0.39	0.45	0.45	0.46
Uses certain door	0.59	0.30	0.45	0.37	0.40
Difficult transitions	0.70	0.32	0.39	0.35	0.51
Insists on routine	0.78	0.37	0.45	0.46	0.51
Insists on time	0.77	0.36	0.40	0.46	0.51
Restricted subscale					
Videotapes/computer games	0.49	0.19	0.31	0.34	0.52
Preoccupation with subject	0.49	0.21	0.38	0.40	0.70
Attached to object	0.54	0.34	0.56	0.48	0.62

Note: Items have been grouped with their respective subscales based on the factor loadings presented in Table 2

Table 5 Subscale statistics: Cronbach's alpha and interrater reliability

Subscale	Alpha	Interrater reliability: Ohio sample (n = 28)	Interrater reliability: J. Iverson sample (n = 18)	Mean number of typographies in SCAS (SD)	Mean score in SCAS (SD)
Ritualistic/sameness	0.91	0.67	0.72	6.65 (3.68)	11.79 (8.65)
Self–injurious	0.84	0.62	0.88	2.27 (2.31)	3.65 (4.50)
Stereotypic	0.85	0.73	–0.24	4.97 (2.61)	8.67 (6.09)
Compulsive	0.79	0.57	0.95	2.78 (1.79)	5.01 (4.19)
Restricted	0.78	0.69	0.41	2.12 (1.03)	4.26 (2.86)
Total score	N/A	0.70	0.30	18.81 (8.57)	33.14 (20.60)

Note: NA = not applicable

Table 6 Subscale correlations with RBS-R Total Score and Global Severity Score

Subscale	Total score	Global severity score
Ritualistic/sameness	0.88	0.64
Self–injurious	0.63	0.48
Stereotypic	0.77	0.58
Compulsive	0.68	0.43
Restricted	0.71	0.50

Note: All correlations significant at the $P < .001$ level. Total Score = sum of all subscale scores

significance in this sample (<.40 = poor, .49–.59 = fair; .60–.79 = good, .75–1.00 = excellent; Cicchetti & Rourke, 2004; Fleiss, Levin, & Patick, 2003)

The second sample ($n = 18$) was obtained from the J. Iverson Riddle Developmental Center, a residential facility. All ratings were completed by staff who worked directly with the subjects. The participants in this sample were between 16 years and 56 years of age (mean = 42.6, SD = 10.0) and most had severe or profound mental retardation. Subscale interrater reliability ranged from –0.24 (Stereotypic Behavior) to 0.95 (Compulsive Behavior) (median = 0.72). The representativeness of some of the Iverson Riddle scores is somewhat questionable as they were frequently influenced by a small number of subjects having the target behavior (addressed further in the Discussion) (see Table 5).

Sample Norms for Subscale Scores

To help professionals to interpret scores for clients with ASDs, we derived means and standard deviations for our subscale scoring system. These norms for the whole sample, broken out by gender, age, and educational setting, are presented in Table 7. It is likely that a multitude of subject characteristics could affect scores on the RBS-R. A related paper is under development, in which we assess the effects on RBS-R scores of age, sex, race, degree of autism, level of mental retardation, school placement, comorbid behavioral problems (such as anxiety and hyperactivity), family history of mood disorders, and medication use.

Discussion

Sample Characteristics and Response Rate

Although our sample size of 307 was large enough to support the use of factor analysis, our response rate of 32% was less than we hoped for. Our use of a single-mailing strategy was prompted by the recent HIPAA guidelines, which prohibit organizations like the SCAS from releasing address labels without prior written approval of its members. Our preference would have been to use a multiple-mailing strategy that would have targeted nonresponders to our earlier mailings. Although this rate of response (32%) was lower than achieved in our previous survey work [Aman, Lam, & Collier-Crespin, 2003 (55% response rate); Langworthy-Lam, Aman, & Van Bourgondien, 2002 (47%)], the current response rate is respectable for a single mailing. With mail surveys, response rates of less than 40% are common, if not the norm (Kerlinger & Lee, 2000).

Table 7 Sample norms for Amended Scoring System for the RBS–R

	Range of *N**	Rituals/Sameness Behavior		Stereotypic Behavior		Self–injurious Behavior		Compulsive Behavior		Restricted Interests		Total Score	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
All subjects	267–307	11.79	*8.65*	8.57	*6.09*	3.65	*4.50*	5.01	*4.19*	4.26	*2.86*	33.14	*20.60*
Gender													
Male	219–253	11.61	*8.55*	8.67	*6.15*	3.36	*4.21*	4.97	*4.26*	4.27	*2.86*	32.91	*20.71*
Female	46–52	12.51	*9.28*	8.10	*5.92*	4.98	*5.61*	5.18	*3.66*	4.29	*2.86*	34.09	*20.65*
Age													
0–5 years	31–33	11.35	*9.74*	11.06	*6.62*	4.06	*5.96*	5.36	*4.31*	4.61	*2.78*	37.06	*24.33*
6–12 years	107–113	10.16	*7.68*	7.97	*5.08*	3.14	*3.80*	4.11	*3.67*	4.02	*2.66*	29.50	*17.91*
13–20 years	72–88	12.78	*8.09*	9.37	*6.65*	4.26	*5.13*	5.64	*4.67*	4.82	*2.97*	37.03	*22.18*
21+ years	49–65	13.03	*10.32*	7.33	*6.54*	3.43	*3.90*	5.41	*3.93*	3.63	*2.94*	31.80	*20.99*
Educational setting													
Regular class	48–51	8.10	*7.32*	5.90	*5.06*	3.06	*4.30*	3.96	*3.96*	3.39	*2.79*	23.77	*19.51*
Special class	154–177	12.05	*3.23*	8.79	*5.95*	3.23	*4.16*	5.05	*3.99*	4.59	*2.72*	34.11	*19.80*
Special school	35–45	15.60	*9.36*	10.86	*6.21*	5.38	*4.80*	6.63	*4.95*	4.58	*3.08*	42.00	*21.81*
Other	26–29	12.24	*9.13*	9.00	*7.00*	4.93	*5.84*	4.64	*3.77*	3.72	*3.11*	34.92	*20.62*

**Note: N* values range per subscale score due to scattered missing data

It is important to note that this sample, like those of other mail surveys conducted in statewide Autism Societies (e.g., Langworthy-Lam et al., 2002; Aman et al., 2003), may not be truly representative of all individuals with autism for several reasons. First, people who maintain membership in groups such as the SCAS may be particularly active, informed caregivers. Second, it is possible that respondents who took the time and effort to complete the survey might have done so due to the saliency of RRBs to their family member with autism. Third, it is possible (indeed probable) that the sample was more characteristic of the ''PDD umbrella'' through a variety of diagnostic pathways (e.g., DSM-III-R, ADOS/ADI-R.) However, issues of reduced representativeness of this sort are not necessarily of significant concern. This is because the primary focus in the present study was on the structure of the RBS-R and on revealing the relationships between items on the scale (DeVellis, 1991). It is difficult to see how a less-than-perfectly-representative sample would have affected the factor structure of the RBS-R. However, it is possible that the *normative* data are biased to some unknown degree.

Factor Structure and Item Content

We chose the five-factor solution as most appropriate for this sample due to: (a) easily interpretable factors, (b) good measures of internal consistency, (c) high item-total correlations, and (d) reasonable fit as measured by the RMSEA statistic. In comparing this five-factor solution with Bodfish et al.'s original six subscales, the most apparent difference was that the five-factor solution collapsed the original Ritualistic Behavior and Sameness Behavior subscales into one (labeled ''Ritualistic/Sameness Behavior'' here). In fact, these subscales continued to load on one-factor even when six-factors were extracted. On examining these items, it makes intuitive sense that they share common attributes. The RBS-R defines Ritualistic Behavior as ''performing activities of daily living in a similar matter,'' and Sameness Behavior as ''resistance to change, insisting that things stay the same.'' It makes clinical sense that performing a ritual is strongly related to a need for sameness and consistency, as the present factor analysis indicates. Although the original Ritualistic Behavior subscale is oriented more towards *activities* and the Sameness Behavior subscale includes more references to specific *objects*, they share the construct of the need for invariance in both activities *and* in the environment.

The remaining four subscales of the RBS-R (Stereotypic Behavior, Self-injurious Behavior, Compulsive Behavior, and Restricted Interests) were largely replicated by the factor analysis; 22 of the 26 remaining items (85%) loaded on their hypothesized factors. The four items that did *not* resolve onto their hypothesized factors are worth noting. Three of these items loaded onto the Stereotypic Behavior factor. The first was item (22: ''Need to touch, tap, or rub items, surfaces, or people,'' which was originally assigned to the Compulsive Behavior subscale. The other two items were originally assigned to Restricted Interests (item (42: ''Preoccupation with part of object rather than the whole object'' and item (43: ''Fascination, preoccupation with movement/things that move''). Although these three items may have been intended to reflect more internal, cognitive states, in this sample they clearly were more linked with the Stereotypic Behavior factor.

Another important difference revealed by the present study concerned the Restricted Interests subscale. As discussed above, two of this subscale's four items resolved onto the Stereotypic Behavior factor. The remaining two items (item 40: ''Fascination, preoccupation with one subject or activity'' and item 41: ''Strongly attached to one specific object'') resolved onto their hypothesized factor of Restricted Interests, along with an item from the Sameness Behavior subscale (item 36: ''Likes the same CD, tape, record, or piece of music played continually''). Restricted Behavior, as defined in the RBS-R, is a ''limited range of focus, interest, or activity;'' hence liking to watch a certain video or hear a piece of music seems to be a good fit under this definition.

The fact that only three items loaded on the Restricted Interests factor is a potential weakness of this subscale. Thurstone (1947) considered three items as the minimum number needed to consider a set of items as comprising a factor. However, this factor was retained due to its potential clinical importance in ASDs, as circumscribed interests are particularly characteristic of, if not restricted to, ASDs (Frith, 1989; Kanner, 1943; Wing & Gould, 1979). Since this subscale meets the *minimum standards* in terms of factorial structure, we think that it is best considered an exploratory (or experimental) subscale at this point. In future work with the RBS-R, it may well be worth expanding the possible pool of Restricted Interest items to see if this subscale can be made longer, more representative, and presumably more reliable.

Although the RBS-R is unique in that it captures so much of the restricted, repetitive behavior found in autism, it is interesting that there is no item on the scale that directly assesses echolalia, a common repetitive behavior in ASDs. Some forms of echolalia may be captured on item 28 of the scale (''Repeats

same topic(s) during social interactions; Repetitive questioning....''), but it is not assessed directly on the RBS—R. Given the repetitive nature of echolalia and a reported prevalence rate of 75% in individuals with autism (Charlop, 1992), further investigation is warranted to clarify whether more items assessing echolalia should be added to the RBS-R.

Psychometric Characteristics of Revised Subscales

Overall, our five-subscale, 38-item scoring method for the RBS-R appeared to have sound psychometric characteristics. Crohnbach's alphas for all of the subscales were satisfactorily high (between 0.78 to 0.91, mean = 0.83). However, interrater reliability findings varied between the two samples (Ohio sample and the J. Iverson Riddle Center).

The Ohio sample (n = 28) subscale correlations ranged from 0.57 to 0.73 (mean = 0.66). Subjects in this sample were primarily children with mild or moderate levels of intellectual handicap. Achenbach, McConaughy, and Howell (1987) conducted a meta-analysis of 119 studies of interrater reliability. They found that the average reliability, when raters had similar roles (e.g., pairs of caregivers, pairs of teachers, etc.), was 0.60. Therefore, the results from the Ohio sample suggest that the interrater reliability of the RBS-R may well be slightly better than average.

The raters from the J. Iverson Riddle Center (an inpatient residential treatment center for individuals with mental retardation; n = 18) were direct care staff. Subscale correlations ranged from very poor (–0.24; Stereotypic Behavior) to exceptionally high (0.95; Compulsive Behavior). Inspection of scatterplots suggested that this was due to two influences. On the Stereotypic Behavior subscale, there was considerable disagreement between raters, which led to the ICC value of –0.24. The exceptionally high ICC value found for the Compulsive Behavior subscale appeared to be related to the fact that very few (3 out of 18) of the subjects were rated as having *any* compulsive behaviors. It may be that individuals (usually with severe and profound mental retardation) who tend to reside in such residential facilities may not have a broad *range* of RRBs and, therefore, they may not be the best participants for assessing psychometric characteristics.

Overall, ratings of internal consistency (data from the SCAS) and interrater reliability (in the Ohio sample) support the use of RBS-R, with some revisions in scoring, in outpatient settings. However, more research is needed to clarify its utility in settings where the subjects are likely to have severe and profound levels of intellectual handicap.

Total Score and Global Severity Score

It is common within pharmacological and other types of investigations to designate a single ''primary outcome variable'' to assess the independent variable under study. We included the Global Severity Score to see if it may be a suitable primary outcome measure. However, the Global Score only correlated with the various subscales in the range of .43–.64, as compared with the Total Score, which correlated in the range of .63–.88 with the subscales (Table 6). For the Global Severity score, raters were asked to consider the *impact of the behaviors on people around the subject*, whereas the 43 items were simply rated for severity of the ''problem,'' further undefined. This disparity in instructions leading to the Total score and Global Severity score could account in part for differences between them. In any case, we recommend using the Total Score as the best single overall indicator of RRBs.

Availability of Amended Scoring Forms

To the best of our knowledge, this is the first empirical study to determine the factor structure of the RBS-R. Although the results do not fully support Bodfish and colleagues' six-subscale structure, the solutions are quite similar overall. Our five-factor solution is likely to be more stable and reproducible than the original six-subscale approach, although this needs to be confirmed by future research. The psychometric characteristics of the five-subscale scoring method of the RBS-R appear to be sound, particularly in outpatient settings. Therefore, researchers and clinicians using the RBS-R may wish to use our amended scoring procedures, which are available from both authors as pdf files. It is also available from the Web at http://psychmed.osu.edu.

Limitations

As noted, mail surveys of this type are likely to result in a sample which may not be completely representative of people with autism. Therefore, it is unknown how representative the current data are, and this suggests that professionals should exercise appropriate caution in using our preliminary norms. Another limitation was that the RBS-R was presented to participants in a physical layout that was already divided into the subscales originally designated by Bodfish and colleagues. This could have influenced ratings, as raters might have assumed that items under a given subscale should logically be grouped together. However, to pose

a fair test of the RBS-R's factor structure, it was important that the scale be presented in a format similar to that developed by Bodfish and associates. As certain items did load outside of their hypothesized subscales, this suggests that the presentation of items in groupings did not overly determine the findings.

The finding that the RBS-R can be used reliably to assess multiple types of RRBs is important to the study of autism. Identification of subtypes of RRB may help to identify specific genetic or neurobiological components of autism. In addition, the RBS-R may be a useful tool in the assessment of treatment effects.

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