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Repetitive Motor Movement, Social Responsiveness, and Global Development in Children with Autism Spectrum Disorder

by

Jenny R. Waltzer

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The City University of New York

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Abstract

In individuals with Autism spectrum disorder, repetitive and stereotyped behaviors are a diagnostic feature. In this study, we assessed whether specific repetitive motor movements (involving the body), are associated with social abilities and global development. Additionally, we evaluated whether our observational measures of specific repetitive behaviors corresponded to standard diagnostic measures. Sixty-nine children, aged 32 to 82 months, with a diagnosis of autism spectrum disorder or autism were enrolled. Structured observations were coded during playtime for the presence of repetitive motor movements. The relation between specific behaviors and developmental level were calculated with Spearman correlation coefficients. Repetitive motor movements were significantly correlated with language age and language developmental quotients. They were not significantly associated with corresponding items from standard diagnostic measures, the Autism Diagnostic Observation Schedule (ADOS) and Autism Diagnostic Inventory (ADI), or response to others’ bids for Joint attention, an indicator of social abilities. These findings suggest that children exhibiting repetitive motor behaviors are more likely to display expressive developmental delays. Focusing on the limitations of the present study, such as poor video quality and a complex coding scheme, may help improve reliability in future research.

Keywords: Autism spectrum disorder, Autism, ADI, ADOS, Joint attention, Global Development
Repetitive Motor Movement, Social Responsiveness, and Global Development in Children with Autism Spectrum Disorder

What is Autism?

Autism spectrum disorder (ASD) is a neurodevelopmental disorder affecting one out of every sixty-eight children in the United States, and it is almost five times more common among boys than girls (CDC, 2014). ASD is characterized by deficits in social communication and interaction and the presence of repetitive interests and behaviors. The symptoms must be present at early development and cannot be related to other medical or neurological conditions (DSM-5, 2013). This is a lifelong condition that currently has an unclear etiology and no known cure (Elder et al., 2009).

ASD is categorized into levels of severity based on the behavioral criteria an individual exhibits to support the diagnosis. The symptoms must cause clinically significant impairment in social, occupational, or other important areas of functioning, and are not better explained by intellectual disability or global developmental delay, however, they can co-occur to make comorbid diagnoses of ASD and intellectual disability (DSM-5, 2013).

Defining Repetitive and Stereotyped Behaviors

According to the DSM-5 (2013), the category of repetitive and stereotyped behaviors (RSBs) includes (1) stereotyped or repetitive motor movements, use of objects, or speech, (2) insistence on sameness, inflexible adherence to routines, or ritualized patterns or verbal nonverbal behavior, (3) highly restricted, fixated interests that are abnormal in intensity or focus, (4) hyper – or hypo-activity to sensory input or unusual interests in sensory aspects of the environment. These behaviors typically occur with high frequency and present with a life-long course that markedly interferes with normal development (Matson et al., 2009).
Lam et al. (2008) used a factor analysis to evaluate symptom domains and heredity. The researchers were particularly interested in three symptom domains associated with three distinct Restricted Repetitive Behaviors (RRB): Repetitive Motor Behaviors (RMB), Insistence on Sameness (IS), and Circumscribed Interests (CI). Their study sample included 316 participants (predominantly male, 82.5%) from 20 months to 29 years of age with a diagnosis of Autism spectrum disorder. The symptom domains were measured by the Autism Diagnostic Interview-Revised (ADI-R) and analyzed using an exploratory factor analysis (EFA). The EFA is used to measure theoretical structure of behavioral domains and examine the internal reliability of psychometric measures. The results of the RRB analyses showed that higher RRB scores were associated with younger age, lower verbal IQ, greater social deficits, greater communication impairments, and loss of skills. Higher IS scores were associated with greater communication impairments in verbal subjects and greater social deficits. In addition, the findings suggest that individuals with multiple types of RRBs tend to exhibit more severe impairments in social and communication domains.

The study by Lam and colleagues (2008) also assessed familial relations (i.e., hereditary nature) in RRBs by comparing RMB, IS, and CI scores among 126 sibling pairs. To be included, both of the siblings were required to have a diagnosis of autistic disorder (DSM-4, 1994). While there was no significant correlation between sibling manifestations of RMB, familial manifestations of IS and CI were found to be significantly correlated. These familial patterns lend support to the notion of a potential genetic mechanism underlying the expression of IS and CI.
RSBs in Toddlers

The presence of RSBs in infants and toddlers has been documented by both parental and laboratory observation. Matson et al. (2009) proposed a new diagnostic scale that allowed for a more systematic approach to studying and rating the nature of these stereotyped and ritualistic behaviors in young children. The participants, ranging from 17 to 37 months of age, were infants diagnosed with ASD, young children at risk for a developmental disability, and children suffering from severe medical conditions. The children were measured using a three-part scale entitled the BISCUIT (Baby and Infant Scale for Children with aUtIsm Traits). Only part I of the BISCUIT was used to assess symptoms of ASD, specifically the repetitive/restricted interests sub-scale. This section of the measure captures parental evaluation of whether their child has expressed interest in a highly restricted set of activities, becomes upset if there is change in routine, isolates self, or shows abnormal, repetitive hand or arm movement. Caregivers were instructed to rate their child’s behaviors as compared to a typically developing same-age peer on a three-point Likert scale (0 being no impairment and 2 very different/severe impairment). The results showed that stereotyped and repetitive behaviors were more common in classic autism than in Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS). Further, children without ASD but with other developmental disabilities or medical conditions were the least likely to exhibit these behaviors.

Matson’s (2009) study showed that RSBs are common in ASD, but does not address whether these behaviors are different across ages. Kim and Lord’s (2010) study focused on ASD and whether or not there is a difference in level of severity across ages. They examined the expression of restricted and repetitive behaviors in children with ASD, children with non-spectrum disorders (NS), such as intellectual disabilities and language disorders, and typically
developing (TD) children. The study hypothesized that RRBs would be more prevalent and greater in severity in children with ASD than in NS and TD children. The participants (8-56 months of age) in the study were 121 children with ASD, 71 children with PDD-NOS, 90 children with NS, and 173 TD children. Logistic regression for repeated measures was used to examine the differences in prevalence of RRBs, and a hierarchical regression analysis was used to measure predictability of RRBs. The results showed that children with autism and PDD-NOS expressed a higher prevalence of RRBs than NS and TD children. Across all ages, RRBs in children with autism were almost three times more common than in children with NS, while RRBs in children with PDD-NOS were more than two times higher than in children with NS. Age was significant for the TD group indicating that RRBs in TD children were less severe as age increased. The severity of RRBs in the autism and PDD-NOS groups were similar across all ages, thereby suggesting a stability of the RRBs over time. These results may suggest that RRBs demonstrate systematic patterns in their manifestation across different diagnoses - an effect worth exploring with future research as a behavior metric that may assist in the ASD diagnostic process.

The frequency and duration at which RSBs occur, and the predictive relationships between RSBs and developmental level, are also important factors to look at, as postulated by Watt et al. (2008). Watt’s study looked at RSBs in children with ASD, developmental delays without ASD, and typically developing (TD) children. The researchers hypothesized that children with ASD would exhibit a higher frequency of RSBs, that RSBs would be negatively correlated with developmental level, and that RSBs would be positively correlated with social symptoms. They analyzed observation videos of 125 children (18 to 24 months of age), coding for repetitive behaviors. These were defined as three or more repetitions or repetitions occurring
with three or more objects (collects, lines up/stacks) that were not used as a communication measure (i.e. waving hand as a greeting). The behaviors were classified as RSB with objects, body, or sensory behaviors. Results showed that children with ASD demonstrated significantly higher frequency and duration of RSB with objects, body, and sensory behaviors. However, sensory behaviors were not clearly related to repetitive behaviors with objects or body. RSB with objects was concurrently related to developmental level (in the child’s second year) and also predicted the child’s developmental outcome at 3 years of age. Ultimately, these researchers found that RSBs helped predict the overall severity of ASD in children by 3 years of age. This finding suggests that repetitive behaviors can be used as a diagnostic feature to identify at-risk children who would be ideal candidates for early intervention.

**RSBs and Global Development Delay (GDD)**

Many children with autism have more severe impairment of their communication and social functioning (elements of GDD) compared to typically developing children (Kim and Lord, 2010). Kim and Lord’s (2010) study looked for differences in non-verbal IQ (NVIQ) scores based upon 6 age cohorts (children from 8-56 months, with 5 month intervals). The results demonstrated that lower NVIQ scores predicted higher RRB scores for all diagnostic groups across all ages, thereby substantiating the hypothesized correlation between NVIQ and RRBs. As NVIQ scores decreased, the rate of RSBs increased. The study by Watt et al. (2008), looked for a relationship between RSBs and developmental outcomes. To examine predictive relations between early RSB and developmental outcomes, bivariate correlations controlling for age between the RSB measures in the second year and verbal and nonverbal scores on the Mullen Scale of Early Learning (MSEL, assesses for expressive and receptive language skills) and the adaptive behavior composite of the Vineland Adaptive Behavior Scales (VABS, measure of
adaptive behavior for children with special needs, such as, coping with a new environment and/or learn every day new skills) were computed. The MSEL and VABS are diagnostic measures used to determine developmental level. In children with ASD, significant moderate correlations were observed between RSB with objects and verbal and nonverbal DQ on the MSEL at three years. However, there was no significant correlation between repetitive behaviors with body and social affect symptoms. Further research on RSBs with objects in young children could help with early interventions and targeting developmental outcomes.

Bishop et al. (2009) studied the prevalence of RRBs in children with ASD at different age levels and ability levels and how chronological age relates to IQ and prevalence and severity of RRBs. The study included 830 participants from 15 months to 11 years with a mean age of 58 months. Participants had diagnoses of Autism, PDD-NOS, and Asperger syndrome (2 participants). Children were assessed using several diagnostic measures including, the ADI-R (parent reported autism symptoms), VABS (measures adaptive behavior for children with special needs), and ADOS (observational report on social interactions) for standard assessment and MSEL (examines expressive and receptive language abilities) and Differential Ability Scales (DAS, measures cognitive abilities) for cognitive functioning. The author’s conclusion indicates that the relationship between nonverbal IQ and the presence of RRBs becomes more pronounced as children with ASD get older. In older children, RRBs were correlated with lower IQ, i.e. children with lower IQ scores were more likely to exhibit repetitive behaviors. The study also suggests that specific RRBs can be more common in children with lower NVIQs and other RRBs in higher functioning children. The report stated, “Importantly, though, while the percentage of children who exhibited a given behavior varied by age and NVIQ, most behaviors were exhibited by a substantial proportion of children in every age and IQ group.”
Autism and Social Deficits

An association between RSBs and social skills was found by Watt et al. (2008) when they analyzed developmental and social progress using the Communication and Symbolic Behavior Scale (CSBS). The CSBS measures developmental level using the “symbolic composite” (measures of verbal comprehension, function, symbolic and constructive play) and measures social competence using the “social composite” (measures of emotion and eye gaze, social interaction, joint attention). The authors concluded that RSBs with objects showed a significant negative correlation with social skills in the second year of life, but there was no correlation when controlling for developmental level. It is possible that these intrusive and interruptive RSBs often cause children with ASD to have difficulty with social attention, leading to deficits of social interaction.

Hypothesis

The present study uses observational measures to evaluate the presence of repetitive motor movements in children with ASD. Previous research concludes that repetitive behaviors have an association with children’s global development and impact social deficits. For example, Lam et. al (2008) found that higher repetitive motor behavior scores were associated with lower verbal IQ and great social deficits. Research also shows that RSBs can be used as a diagnostic marker and can help facilitate early intervention as shown in a study by Watt et al. (2008). Their findings show that RSBs helped predict the overall severity of ASD in children by 3 years of age. The repetitive motor movements observed in the present study were those that involved the body specifically. These behaviors are defined as banging the body on an object or any other body part, stiffening, running and jumping, exploring and pacing (Table 1). The current study had three hypotheses: we predicted that our observational measures would be consistent with
corresponding items from standard diagnostic measures, the ADOS (Lord et al., 2000) and the ADI (Rutter et al., 2003). That is, we predict a significant correlation between the observed frequency of RMM and the corresponding items of the ADOS and ADI. Second, we hypothesize a negative correlation between RMM and measures of global development such as NVDQ, LDQ, Nonverbal Age and Language age. Third, we also hypothesize a negative correlation between RMM and children’s social responsiveness (i.e., joint attention).

Table 1

*Repetitive Motor Movement (RMM)*

*Descriptive Definitions*

<table>
<thead>
<tr>
<th>RSB</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSB with Body</td>
<td>Banging the body on an object or any other body part</td>
</tr>
<tr>
<td>Flapping</td>
<td>Moving the hand(s), wrist(s), or arm(s) back and forth/up and down at least 3 times; may be horizontally or vertically</td>
</tr>
<tr>
<td>Stiffening</td>
<td>Posturing the fingers, hand, or arm, usually with one or more of the fingers spread (fanning), or fists clenched for at least 2 seconds</td>
</tr>
<tr>
<td>Running/Jumping</td>
<td>Attention being diverted from play as child disengages and begins bouncing, running, or jumping around the room or in place</td>
</tr>
<tr>
<td>Exploring/Pacing</td>
<td>Attention being diverted from play as the child disengages and begins pacing or exploring the room in a spontaneous fashion away from the toys, mom, or the game</td>
</tr>
</tbody>
</table>

*Note: Descriptive schema used for coding observational data*

Methods

**Participants**

The current study evaluates baseline data collected as part of a larger randomized controlled trial evaluating the efficacy of Focused Playtime Intervention (Siller, Hutman, & Sigman, 2013).

Participants were identified as children diagnosed with ASD and autism ranging from 32 to 82 months of age ($M=57.13$, $SD=12.27$). The total participant population was 70 children: 6 females and 64 males. The ethnic background composition was 47.2% Hispanic (17), 22.2% Caucasian (8), 8.3% Black (3), 11.1% Asian (4), and 11.1% “mixed/other” (4). Mothers
participating in the study ranged in age from 22.58 years to 47.83 years ($M = 35.71$, $SD = 5.77$). When they identified marital statuses, 80% were married, 14.3% single, 2.9% divorced, and 2.9% separated. Mothers’ years of education ranged from 10 to 22 years; 19.4% completed a graduate degree, 22.2% completed standard college/university (BA degree), 36.1% attended college but did not receive a degree, 19.4% were high school graduates, and 2.8% completed 10th-11th grade ($M=15.34$, $SD = 2.56$). The annual household income ranged from $0 to $900,000, with a median of $40,000.

The inclusion criteria for participants in the study were as follows: (1) the child was 6 years or younger when entering the study, (2) the child had been previously diagnosed with Autism spectrum disorder, (3) the child showed limited or no use of spoken language (generally fewer than 25 words and no phrases, based on parent report), (4) the child’s mother was fluent in English and willing/available to participate in all assessment and treatment sessions, and (5) the family lived within a reasonable travel distance from the research lab, generally less than 90 minutes.

**Procedure**

**Coding RSBs**

Video segments, ten minutes in length, were recorded during structured playtime between the caregiver and the child. All interactions were recorded using a standardized toy set. The toy sets included a xylophone, shape sorter with lock and key, velcro board with farm animals, cars, pop-up figures, a birthday cake with velcro candles and cake cutter, colored shape viewers, and stackable squares in various sizes. The caregivers were instructed to “play as they normally would,” and the videographer was instructed to capture an optimal view of (a) the child’s face, (b) the toy the child was playing with, and (c) the mother’s hands (Siller and Sigman, 2008).
For each videotaped observation, a two-minute episode (minutes 3 & 4) was selected for observational coding. Each segment was watched and coded a total of three times, by each of the researchers. During the segments, coders were able to rewind and review if they thought they had missed a behavior. The researchers used a detailed and specific coding schema that encompassed five forms of repetitive motor movements (Table 1). The total number of repetitive motor movements was calculated as the sum of all five behavioral categories. One hundred and six interactions were coded by two independent observers. Intraclass correlation coefficients revealed adequate levels of reliability for the total number of repetitive motor movements, ICC = .81.

*Autism Diagnostic Review (ADI)*

The Autism Diagnostic Review (ADI) is a caregiver interview that provides a comprehensive developmental history. Parents participate in a standardized interview, and parent responses are rated using 4-point rating scales. The child’s demographic information, developmental milestones, language development, social behaviors and current behaviors are collected from this assessment. This interview is also used to determine a treatment plan for the child once a formal diagnosis has been determined. The treatment is dependent on the child and mother’s needs. For each item, a score is given from 0-3. A score of 0, means a behavior is not present, 2, behavior is sufficiently frequent, 3 behavior causes severe social impairment.

The current analyses focus on two specific items evaluating parent-reported RSBs with body. A higher score reflects higher levels of symptoms. Item 77 on the ADI measures hand and finger mannerisms defined as “…typically involve rapid, voluntary repetitious movements of the fingers and hands, often, but not always within the line of the subject’s vision” (Rutter et al., 2003). Item 78 on the ADI measures other complex mannerisms or stereotyped body movements
focusing on complex, stereotyped, voluntary whole body movements, such as arm waving while rocking up into tiptoes (Rutter et al., 2003). This measure was administered to collect parent-reported information on children’s RMM’s using a standardized diagnostic tool.

*Autism Diagnostic Inventory Schedule (ADOS)*

The Autism Diagnostic Inventory Schedule (Lord et al., 2001) is a standardized observational measure to determine ASD diagnoses. This assessment is based on observational interactions in social situations and the coding of specific behaviors linked to ASD. The current analyses focus on one specific item. The item evaluates the presence of hand and finger and other complex mannerisms. It is defined as the rate of unusual and/or repetitive movements or posturing of the hands and fingers, arms or whole body (Lord et al., 2001). Based on a structured interaction with the examiner, children are rated on a 3-point scale. Again, higher scores indicate higher symptom levels. The higher the score, the more likely the child is to express that behavior. This measure was administered to collect observational information on children’s RMM’s using a standardized diagnostic tool.

*Early Social Communication Scale (ESCS)*

The ESCS (Mundy et al., 2003) was used to evaluate children’s responses to others’ bids for joint attention. This assessment is a videotaped structured observational measure that required 15 – 25 minutes to be administered. The ESCS is used to measure differences in nonverbal communication skills that typically emerge from 8 – 30 months of age in children. The assessment has three classification categories, joint attention behaviors, behavior requests, and social interaction behaviors. In addition, the tool classifies whether the child is initiating or responding to the contact, i.e. initiating joint attention or responding to joint attention. For this study, response to joint attention was observed and included three kinds of prompts: the
examiner pointing at a picture in a book, the examiner turning his head towards a picture on the wall, and the examiner turning his head and pointing at a picture on the wall. Each prompt is presented 3 times. In “response to head turn with pointing gesture,” after making eye contact with the child the examiner called the child’s name while turning his head and pointing towards the posters. This was done three times. In “response to pointing during book reading,” the examiner called out the child’s name while pointing to a picture book. This was done nine times. The response to joint attention score was calculated by the number of correct responses divided by the total number of trials multiplied by 100 (number of correct responses / total number of trials *100).

*Mullen Scales of Early Learning (MSEL)*

The MSEL is a developmental test intended for children from birth to 68 months of age. Scores on the MSEL are organized into five scales: Visual Reception, Fine Motor, Receptive Language, Expressive Language, and Gross Motor. The MSEL was used in this study to examine expressive and receptive language abilities with repetitive motor behaviors. The developmental quotient is calculated by dividing the developmental age by the chronological age and multiplying by 100. The non-verbal mental age is determined by fine motor and visual reception abilities. The average for language developmental quotient (LDQ) is determined by averaging the non-verbal developmental quotient and the non-verbal mental age. Language age is calculated by mean of two subscales, expressive language and receptive language (Mullen, 1995).

**Results**

Descriptive statistics for all measures are reported in Table 2. The children’s performance on these measures were as follows.
Are repetitive motor movements related to Global Developmental Delays?

We hypothesized that RMM would be negatively correlated with developmental quotients and nonverbal and language age scores and positively correlated with chorological age in this study. To evaluate associations between our observational measure of repetitive motor movements and measures of global development, we computed a series of Spearman correlations. Results are depicted in Table 3. Chronological age did not reveal significant results, $r_s (69) = .200, p=.099$. However, it did express a potential trend that as a child’s gets older, repetitive motor movements increase. Results revealed that there is a significant correlation between repetitive motor movements and language age: $r_s (69) = -.394, p=.001$, nonverbal age: $r_s (69) = -.335, p=.005$, nonverbal developmental quotient: $r_s (69) = -.482, p<.001$, and language developmental quotient: $r_s (69) = -.426, p<.001$.

Are specific diagnostic measures (RSB reported/observed items) correlated with repetitive motor movements?

The current study hypothesized that the diagnostic items used to measure repetitive and stereotyped behaviors in the ADI and ADOS (complex mannerisms, involuntary body motions,
and fine hand and finger motions) would be positively correlated with RMM’s coded. To evaluate associations between our observational measure of repetitive motor movements and the corresponding items of the ADOS and ADI, we completed a series of spearman correlations.

Results revealed that there was no significant correlation with the ADOS and ADI measures. The results were as follows, ADI item #77, \( r_s (68) = .137, p = .264 \), ADI item #78, \( r_s (68) = .067, p = .587 \), ADOS, \( r_s (66) = .058, p = .645 \).

**Are repetitive motor movements related to social deficits?**

The present study hypothesized that children who displayed full response to their names would have increased language skills and fewer repetitive motor movements. We used a Spearman correlation to evaluate the association between our observational measure of repetitive motor movements and children’s responses to others’ bids for joint attention. Results revealed that there was no significant correlation, \( r_s (63) = -.203, p = .110 \).

Table 3.

*Results of Spearman Correlations with Continuous and Experimental Variables*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Repetitive Motor Movements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response to others’ bids for joint attention</td>
<td>( r_s (63) = -.203, p = .110 )</td>
</tr>
<tr>
<td>Hand and Finger Mannerisms, ADI #77</td>
<td>( r_s (68) = .137, p = .264 )</td>
</tr>
<tr>
<td>Complex Mannerisms, ADI #78</td>
<td>( r_s (68) = .067, p = .587 )</td>
</tr>
<tr>
<td>Hand &amp; finger, other complex mannerisms, ADOS</td>
<td>( r_s (66) = .058, p = .645 )</td>
</tr>
<tr>
<td>Nonverbal DQ</td>
<td>( r_s (69) = -.482, p = .000^* )</td>
</tr>
<tr>
<td>Language DQ</td>
<td>( r_s (69) = -.426, p = .000^* )</td>
</tr>
<tr>
<td>Nonverbal Age</td>
<td>( r_s (69) = -.335, p = .005^* )</td>
</tr>
<tr>
<td>Language Age</td>
<td>( r_s (69) = -.394, p = .001^* )</td>
</tr>
<tr>
<td>Chronological Age</td>
<td>( r_s (69) = .200, p = .099 )</td>
</tr>
</tbody>
</table>

*Note. **Correlations were significant at the 0.01 level (2-tailed)**
Are there significant correlations among the experimental variables?

In the interest of answering additional research questions, researchers ran further correlation analyses. We wanted to see if the specific items from the diagnostic measures were correlated with each other, i.e. is there consistency amongst the items that are measuring for similar attributes of RMM. The results in Table 4 illustrate the correlations amongst the diagnostic items used in the study. There was a significant relation between the ADOS item (evaluates the presence of hand and finger and other complex mannerisms) and ADI item #77 (measures hand and finger mannerisms). The correlation between these two measures is promising as they both evaluate for similar mannerisms involving the hands and fingers which is evidence of consistency between the diagnostic measures. Our measure of RRM was not correlated with any of the diagnostic items measured.

Table 4.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ADI Item #77</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. ADI Item #78</td>
<td>0.072</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>3. ADOS</td>
<td>0.406**</td>
<td>0.134</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Correlations with these variables are Spearman rho coefficients, Correlation significant at p<.001**

In table 5, there were significant results with Item #78 of the ADI (measures other complex mannerisms or stereotyped body movements focusing on complex, stereotyped, voluntary whole body movements) and language age, language DQ, and response to other’s bids for joint attention. These results suggest that as the language age, language DQ, and joint attention decrease, complex and repetitive movements involving body increase. In addition, the ADOS diagnostic item was inversely correlated with language DQ, suggesting that as hand and
finger mannerisms increase, language DQ decreases. These results support one of the initial hypotheses that as RRM increase, global developmental factors will decrease i.e. lower verbal and nonverbal IQ and language age scores.

Table 5.

*Diagnostic Measures and Child Development Indicators*

<table>
<thead>
<tr>
<th></th>
<th>ADI Item #77</th>
<th>ADI Item #78</th>
<th>ADOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronological Age</td>
<td>.074</td>
<td>-.056</td>
<td>.062</td>
</tr>
<tr>
<td>Language Age</td>
<td>-.137</td>
<td>-.353**</td>
<td>-.227</td>
</tr>
<tr>
<td>Nonverbal Age</td>
<td>-.125</td>
<td>-.218</td>
<td>-.12</td>
</tr>
<tr>
<td>Language DQ</td>
<td>-.201</td>
<td>-.315**</td>
<td>-.265*</td>
</tr>
<tr>
<td>Nonverbal DQ</td>
<td>-.172</td>
<td>-.085</td>
<td>-.206</td>
</tr>
<tr>
<td>Response to Joint Attention</td>
<td>-.153</td>
<td>-.299*</td>
<td>-.246</td>
</tr>
</tbody>
</table>

*Note: Correlations with these variables are Spearman rho coefficients. Correlation significant at p<.01**, p<.05* *

*Discussion*

This study assessed repetitive and stereotyped behaviors and the rate at which they are expressed by children with autism and ASD. The concurrent relationships to other measures of repetitive motor movements (i.e. the ADOS and ADI), global developmental measures (i.e. language and non-verbal DQ), and social responsiveness (Joint Attention) were also studied.

*Developmental Quotient and repetitive motor movement*

The results of this study show associations between RMM and non-verbal and verbal developmental quotients. In addition, repetitive motor movement was also inversely correlated with language age and nonverbal age. Bishop et al.’s. (2009), conclusion indicates that the relationship between nonverbal IQ and the presence of RRBs becomes more pronounced as children with ASD get older. While we did not have significant results, there was a potential trend to support this conclusion as well. However, Bishop et al.’s. (2009) findings suggest that
older children expressing RRBs are negatively correlated with IQ, i.e. as the behaviors were more prevalent, IQ was lower. This finding supports one of the current study’s conclusions that RRM increase as NVIQ and LDQ decrease.

Lord and Kim’s (2010) results demonstrated that lower NVIQ scores predicted higher RRBs scores for all diagnostic groups across all ages, thereby substantiating the hypothesized negative correlation between NVIQ and RRBs.

Joint attention and repetitive motor movement

The present study hypothesized that children who displayed full responses to their names would have increased language skills and fewer repetitive motor movements. The data analysis did not yield a correlation between social abilities (response to others’ bids for joint attention) and RMMs. Joint attention is important in a child’s development as it reflects an early interest and motivation in sharing with others, impacts one’s ability to maintain interpersonal engagement, and influences overall socialization (Freeman, et al., 2015). To echo the importance of joint attention, Siller et al. (2014) articulated, “By recognizing others as intentional agents, children are able to participate in cultural learning and acquire a broad range of social, communicative, and cognitive abilities.” RMM did not exhibit a significant correlation with social abilities in this study; therefore, presence of RMMs likely does not impede a child’s response to others’ bids for joint attention.

ADI and ADOS and repetitive motor movements

Additionally, the screening measures for ASD (ADI, ADOS, involuntary body motions, and fine hand and finger motions) were not correlated with RMMs. Behaviors such as stiffening (hand and finger motions) and flapping (involuntary body motions) are commonly observed by the interventionist when administering the ADOS and ADI. However, our study included
additional body behaviors, banging (involving body), exploring/pacing, and running/jumping, which could account for additional ADOS and ADI diagnostic variability and therefore, the lack of correlation seen between screening measures and RMMs. Realistically, these additional behaviors are also considered by physicians during the diagnostic process. Accordingly, they should be evaluated and taken into account by researchers who establish the diagnostic criteria.

**Experimental Variable Correlation Matrix**

When evaluating for correlations of the diagnostic measure items, there was a significant relation between the ADOS item (evaluates the presence of hand and finger and other complex mannerisms) and the ADI #77 (measures hand and finger mannerisms). Both of these measures evaluate for similar mannerisms involving the hands and fingers which is evidence of consistency between the different diagnostic measures. None of the diagnostic measures (ADI 77, 78 and ADOS) were correlated with our measure of RMM. This could indicate that the coding schema and/or measuring of RMMs were not clear or the behaviors were not recorded accurately. The results in Table 5, comparing the diagnostic items and global developmental factors, were promising as they tied in nicely to the hypothesis that as RMMs increase, global developmental factors decrease. Our measure of RMM was also inversely correlated with language age and language DQ. Another noteworthy point is that the results only showed a correlation to language age and language DQ and not with nonverbal age and nonverbal DQ. Our measure of RRM was correlated with both verbal and nonverbal measures. In table 5, the correlation of response to other’s bids for joint attention and complex body mannerisms supported our initial hypothesis that RJA would decrease as RMMs increased.

**Difficulties with Inter-coder Reliability and Other Limitations**
Obtaining reliability between coders was difficult. Initially, two coders watched each video segment looking for repetitive behaviors. After several months of coding, sufficient reliability was not obtained because the coders significantly differed in the rates at which they observed the repetitive behaviors. In an effort to obtain reliability, coders tried to accommodate their video observation methods. Initially, they looked for several behaviors simultaneously. This likely caused coders to miss the occurrences of behaviors because some children were very active and displayed several behaviors at once. Coders noted several instances of two behaviors occurring simultaneously or immediately after each other. This introduced uncertainty among the coders regarding which behavior should be coded and also led to uncounted actions. In an updated coding method, each video was watched three times, once for each separate RSB category. This allowed coders to focus on each category individually and allowed for more accurate coding. Unfortunately, the coders still did not obtain a strong reliability score.

Ultimately, the most promising reliability obtained between the two coders in any of the attempted coding methods was for repetitive behaviors involving body. In order to continue the project, one coder watched intake videos of the children and used the initial coding schema for RRM (with body) to remain consistent.

One possible explanation for the poor reliability between our coders could be due to the coding schema. It may be beneficial for researchers to reevaluate the schema and ensure that all behaviors observed during the screening and diagnostic procedures are accounted for and classifiable within the schema. This new schema encompasses the specific behaviors being assessed in screening measures such as the ADOS, ADI, and Mullins Scale.

There was great discrepancy in behavior between videos, possibly causing the poor inter-coder reliability. Potential explanations include the brevity of the video segments and subsequent
unrepresentative depiction of the children’s behavioral styles as well the high variability of repetitive behavior frequencies exhibited by each child.

Another limitation in the coding was the quality of the videos with which the coders were using. The children were far from the camera, the picture was often blurry, and behaviors were subsequently difficult to differentiate. Furthermore, the caregivers often obstructed the view of the children. More strategic placement of the children in front of the camera and higher quality video resolution would allow for the coders to more accurately assess the children. It could also be beneficial for the interventionists to affix additional cameras into the room to encompass many angles of view, in case one view is obstructed.

Moving forward, certain methodological elements of the study need to be adjusted to enable discovery of potentially significant results. Specifically, an improved coding schema and better quality images of the children could result in statistically stronger results.

Conclusion

This study shows that it is important for researchers and interventionists to establish consistent measures for observing and coding RMMs. Examining RMM subtypes and their relationship with other characteristics (global development, social skills) can help clinicians to identify specific types of RMMs that may be associated as predictors of an autism spectrum diagnosis. Nevertheless, interventionists must consider all aspects of behavior when assessing a child in order to implement the proper techniques for learning and developing.

The introduction of the present empirical support for the idea that RSBs obstruct learning in children with ASD. If affected, children are taught how to control and minimize these behaviors, and to focus more energy on developmental tasks. Still yet, important and germane research questions remain. Future research should continue to explore effective and efficient
processes for measuring RSBs, the capability of children with autism to suppress RSBs, and effective tactics to teach children control over RSBs. Clinicians and interventionists could conceivably use these future research outcomes to expand therapeutic programs and apply evidence-based techniques to help children with autism control RSBs. Establishing proper diagnostic practices, early interventions, and effective treatments are crucial to helping children with autism grow, develop, and reach their maximal potential.
References


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