

The Frequency of Restricted and Repetitive Behaviors in a Community Sample of 15-Month-Old Infants

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ABSTRACT: *Objective:* To investigate the frequency and pattern of a wide range of restricted and repetitive behaviors in the second year of life. *Method:* Parents of 139 15-month-old typically developing infants from a community sample completed the Repetitive Behavior Questionnaire-2, giving information on restricted and repetitive behaviors (e.g., stereotyped motor movements, sensory interests, routines and rituals, and preoccupations with restricted interests) seen in their children. *Results:* The Repetitive Behavior Questionnaire-2 was found to be a reliable measure of these behaviors at this age and revealed a high frequency of particular types of repetitive motor movements in 15 month olds. *Conclusion:* These findings have implications for the early detection of disorders characterized by high levels of restricted and repetitive behaviors, such as autism spectrum disorder.

(*J Dev Behav Pediatr* 31:223–229, 2010) **Index terms:** repetitive behaviors, typical development, RBQ-2, autistic spectrum disorder.

Repetitive stereotyped behaviors such as rocking, flapping hands, and banging objects are a normal part of infant development. Observational studies show that these behaviors are extremely frequent from 2 to 12 months and may have a functional significance in development as infants gain the neuromuscular control to execute complex goal-driven actions.^{1,2} Although stereotypies are normal and frequent during infancy, they are also one of several types of repetitive behavior seen in clinical cases of Autism Spectrum Disorder (ASD). Four subtypes of restricted and repetitive behavior (RRB) are identified by the international classification systems DSM-IV³ and ICD-10⁴ as diagnostic criteria for Autism. These are stereotyped motor mannerisms, preoccupations with part-objects or nonfunctional elements of objects (e.g., their sensory aspects), preoccupations with restricted, circumscribed patterns of interest, and com-

pulsive adherence to routines or rituals. Some of these repetitive behavior subtypes are also seen in other childhood clinical conditions such as Prader-Willi syndrome, Obsessive Compulsive Disorder, and Williams syndrome.

Repetitive behaviors have received much less attention in research on the symptomatology of ASD than have social and communicative impairments, as it had been widely assumed that repetitive behaviors were not differentiating for ASD.⁵ However, new observational studies of infant siblings at risk for ASD provide evidence that the earliest differences between high-risk siblings of children of autism and low-risk children may not be with social and communication impairments but with repetitive behaviors.⁶ Although these studies need further replication, specific differences have been found for some high-risk siblings compared with control siblings as early as 12 months in sensory reactions (unusual visual fixations on objects)⁷ and motor stereotypies, particularly arm and finger movements.^{8,9} Other observational research findings from 18 to 24 month olds with communication delay show that those subsequently diagnosed with ASD had greater frequency and duration of repetitive motor movements, repetitive actions on objects, and sensory behaviors than comparison children with developmental delay or typical development.¹⁰

Given the clinical significance of repetitive behaviors for early diagnosis of ASD, there is a need to clarify the pattern of repetitive behaviors seen during typical development in the second year of life. There is virtually no evidence on the frequency of repetitive behaviors in a large sample of typically developing infants between 12 and 18 months, the age at which early behavioral signs of ASD may begin to emerge. The sample sizes of low-risk

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infants in all the above-mentioned studies were no greater than 35. Furthermore, in these studies, the type of repetitive behaviors investigated was confined to those that may be measured in an observation format, i.e., stereotypies and sensory reactions. These studies, thus, excluded routines and rituals or preoccupations that might only be seen at home. Given that the observation techniques used in each of these studies were also rather different from each other in terms of behaviors observed and length of observation, making comparison and consistency of measurement difficult, further validation of the presence of motor and sensory repetitive behaviors, and of other types of repetitive behavior at this age is needed using other methods.

To our knowledge, only two large-scale parent questionnaire studies have been performed in early infancy with a community sample. The first used the Childhood Routines Inventory by Evans et al¹¹ and investigated one type of RRBs (compulsive-like behaviors) in a cross-sectional study of children between 8 and 72 months of age. Compulsive-like behaviors include rituals, routines, preoccupations with restricted interests, and insistence on sameness. This study found a relatively high frequency of these behaviors in 12- to 23-month-old infants, with lower frequency in an older sample of 5 to 6 year olds. However, the Childhood Routines Inventory measure included only one item relating to repetitive actions and one item relating to sensory response, plus two other items measuring these aspects indirectly. Therefore, little is known about the pattern of repetitive behaviors across the full range of expression including motor, sensory, routines, and preoccupations of interest in this specific age band. Further, some of the Childhood Routines Inventory items seem inappropriate for young infants (e.g., making requests to postpone going to bed), and this may explain lower scores in infancy.

The second study investigated children's extreme intense interests (EIIs). This could be considered to be a particular type of RRBs, i.e., circumscribed interests or preoccupation with restricted interests. By using a parent questionnaire and follow-up interview, Deloache et al¹² investigated EIIs in children aged 11 months to 6 years ($N = 177$). The authors found that 66% of children had an intense interest, with 29% of the whole sample being categorized as having an EII. There was a clear gender difference: 75% of those children who had an EII were boys, and the EIIs of boys tended to be rated as more intense. There also appeared to be clear gender differences in the content of EIIs of boys and girls, often following gender stereotypes. The age of onset of these EIIs ranged from 3 months to 42 months, with a mean onset of 18 months and with 90% of EIIs appearing by age 2. The duration of the EIIs was found to be long lasting (from 6 to 36 months). However, this study did not investigate RRBs beyond intense interests, such as rituals or repetitive motor movements.

Screening checklists such as the Modified Checklist for Autism in Toddlers (M-CHAT) questionnaire,¹³ Early

Screening of Autistic Traits (ESAT) questionnaire,¹⁴ and Quantitative Checklist for Autism in Toddlers (Q-CHAT) questionnaire¹⁵ have been used with community samples of infants aged 14 to 54 months and include questions about repetitive behaviors. However, these questions are confined to only one or two items relating to motor stereotypies and to rigid behavior, such as questions about whether the child rocks their body or about adaptation to a change in their routine, and do not include a comprehensive range of RRBs. To our knowledge, only two studies have specifically targeted the full range of autistic-like repetitive behaviors in infants using an informant questionnaire or interview method. One concentrated on children with medical conditions likely to result in a developmental delay,¹⁶ finding elevated rates of repetitive/restricted behavior in children with ASD at 17 to 37 months of age, compared with a sample of infants with Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) and a large control group ($n = 499$) who did not qualify for a diagnosis. However, their scale did not separate items into different behavioral subtypes (e.g., routines/stereotypies) and included nonrepetitive items (e.g., eye-to-eye gaze). The other study found differences between repetitive behaviors in ASD and in children with developmental delay or typical development ($n = 39$) but used a developmental interview that was not specific to RRBs.¹⁷

In this study, we used a parent questionnaire: the Repetitive Behavior Questionnaire-2.¹⁸ The Repetitive Behavior Questionnaire-2 is a 20-item parental questionnaire measure that has recently been used to investigate the presence of the broader range of autistic-like RRBs (repetitive motor stereotypies, sensory interests, rituals, and routines) in a general population sample of children aged 24 to 33 months. Research using this measure indicates that RRBs of all kinds are common in typically developing 2 year olds,¹⁸ and factor analysis grouped these behaviors into four subtypes resembling the groupings reported in the DSM-IV and ICD-10 diagnostic criteria for autism. Support was also found for a two-factor solution in which the four subtypes further combined into a motor and sensory subscale and a rigidity and insistence on sameness subscale.

The aim of this study was to describe the frequency of a wide range of repetitive behaviors including motor, sensory, routines and rituals, and preoccupations with restricted interests in a community sample of 15 month olds. This is an important age at which the earliest signs of ASD begin to emerge and consolidate. The findings will help to determine whether there is a similar frequency and pattern of behaviors at this age as was reported by parents of 2 year olds in Leekam et al's study.¹⁸ Although observational research with typical infant populations up to 12 months suggests that repetitive motor behaviors may still be high at the end of the first year,¹ large-scale cross-sectional questionnaire research indicates that compulsive-like behaviors may be lower at this age, reaching their peak between 24 and 35

months.¹¹ The current questionnaire study documents the full range of RRBs in the second year of life for the first time.

A further aim was to investigate the reliability of using the Repetitive Behavior Questionnaire-2 with a younger age group. The psychometric properties of the questionnaire were found to be good in a group of 2 year olds,¹⁸ with good internal consistency reflected by a high Cronbach's α , but it is not known if this questionnaire is also suitable for use when infants are 15 months. Gender and socioeconomic status have been shown to influence reports of RRBs, with mothers of boys and low socioeconomic status children reporting higher RRBs,¹⁸ hence, these variables were also included.

METHOD

Participants

Mothers of children participating in an ongoing cohort study of children's development in a community sample were asked to complete the Repetitive Behavior Questionnaire-2 when their child was 15 months of age (mean = 14.9, SD = 0.59, range 13–17 months). Mothers of 139 children (74 boys and 65 girls) completed the questionnaire. All responded to at least 90% of the items and, so, were included in the final sample. The majority of the children ($n = 135$) were white and British. All children were born healthy and term. Children were tested with the Preschool Language Scale,¹⁹ and scores showed a normal distribution. Socioeconomic status using Hollingshead's scale²⁰ represented the full range of deprived to affluent. The sample reflected the ethnic and socioeconomic background of the local and regional area. The majority of the mothers who completed the questionnaire ($n = 71$, 51%) were not working outside of the home, and of the 68 who did work, only 15 (10%) worked full-time.

Repetitive Behavior Questionnaire-2

The Repetitive Behavior Questionnaire-2¹⁸ is a 20-item questionnaire that was designed from two existing interview measures: the Repetitive Behaviors Interview²¹ and the Diagnostic Interview for Social and Communication Disorders.²² Its psychometric properties have been found to be good,¹⁸ with high internal consistency.

Parents are asked to rate the frequency with which their child has engaged in a range of restricted and repetitive behaviors over the last month. The items and the response choices are given in Table 1. Item 20, which asks about a child's choice of toys, follows a slightly different format. Following the procedures of previous published research, a mean total repetitiveness score was calculated for each child by adding the score for each item (1–3; including item 20) completed in the questionnaire and dividing by the number of questions completed by the respondent. This produced an average score, indicating the child's level of repetitiveness rang-

ing from 1 to 3, for all items combined. Subscale scores were also calculated by summing across the items within each of the two-factor and four-factor solutions in the Leekam et al's study. For the two-factor solution, the motor-sensory subscale contained nine items and the rigidity, routines, and preoccupations subscale contained eight items. For the four-factor solution, the motor subscale contained five items, the rigidity subscale seven items, the preoccupation subscale seven items, and the sensory subscale four items.

Procedure

Mothers were asked to complete the Repetitive Behavior Questionnaire-2 in advance of a visit to the Child Development Unit at the University when their infants were 15 months of age. Mothers who did not return their questionnaire at this visit were given a prepaid envelope and asked to return their questionnaire by post. Only two mothers did not return the questionnaire. Any mothers with reading difficulties were helped to complete the questionnaire by a researcher during the visit.

RESULTS

Frequency of Restricted and Repetitive Behaviors at 15 Months

Table 1 presents the individual questionnaire items and response options, and the number and percentage of participants completing them. The "occasional/mild" response range was endorsed by between 2% and 52% of the sample for each item; the "marked" range was endorsed by between 2% and 60% for each item. Of particular note are the high proportion of parents endorsing "Repetitively fiddle with toys or other items" (60%) and "Pace or move around repetitively" (51%) as marked behaviors at 15 months. Items with very low endorsement (70% or more never or rarely) at 15 months are "Special interest in the smell of people or objects," "Collect or hoard items," "Insist on things remaining the same," "Get upset about minor changes to objects," "Aspects of daily routine must remain the same," "Insist on doing things in a certain way or redoing things until they are 'just right'," "Insist on wearing the same clothes or refuse to wear new clothes," and "Insist on eating the same foods or a very small range of foods."

Total Repetitive Behaviors and Subscale Scores at 15 Months

Analysis revealed that the total and subscale scores were positively skewed, and therefore parametric tests were performed on logarithmically transformed scores. Table 2 gives the mean total and subscale scores for the sample ($N = 139$). As can be seen from Table 2, results for the two-factor subscales shows higher scores for the motor and sensory subscale than the rigidity/routines/preoccupations scale ($F_{(1,138)} = 188.74$, $p < .001$), whereas results for the four-factor subscales shows that

Table 1. Response Frequencies for Each RBQ-2 Item^a

Section 1	Does Your Child	Never or Rarely, n (%)	One or More Times Daily, n (%)	15 or More Times Daily (or at Least Once an hr)^b, n (%)	Mean (SD)
1	Arrange toys or other items in rows or patterns? N = 139	63 (45.3)	72 (51.8)	4 (2.9)	1.58 (0.55)
2	Repetitively fiddle with toys or other items? (e.g., spin, twiddle, bang, tap, twist, or flick anything repeatedly?) N = 136	15 (11.0)	40 (29.4)	81 (59.6)	2.49 (0.69)
3	Spin him/herself around and around? N = 137	57 (41.6)	57 (41.6)	23 (16.8)	1.75 (0.73)
4	Rock backwards and forwards, or side to side, either when sitting or when standing? N = 135	44 (32.6)	48 (35.6)	43 (31.9)	1.99 (0.81)
5	Pace or move around repetitively? (e.g., walk to and fro across a room, or around the same path in the garden?) N = 138	33 (23.9)	35 (25.4)	70 (50.7)	2.27 (0.82)
6	Make repetitive hand and/or finger movements? (e.g., flap, wave, or flick, his/her hands or fingers repetitively?) N = 139	46 (33.1)	51 (36.7)	42 (30.2)	1.97 (0.80)
Section 2	Does Your Child	Never or Rarely	Mild or Occasional	Marked or Notable	Mean (SD)
7	Have a fascination with specific objects? (e.g., trains, road signs or other things?) N = 139	28 (20.1)	68 (48.9)	43 (30.9)	2.11 (0.71)
8	Like to look at objects from particular or unusual angles? N = 136	51 (37.5)	66 (48.5)	19 (14.0)	1.76 (0.68)
9	Have a special interest in the smell of people or objects? N = 138	97 (70.3)	33 (23.9)	8 (5.8)	1.36 (0.59)
10	Have a special interest in the feel of different surfaces? N = 138	28 (20.3)	73 (52.9)	37 (26.8)	2.07 (0.69)
11	Have any special objects he/she likes to carry around? (e.g., a teddy, a blanket, a book, or a stick?) N = 138	54 (39.1)	32 (23.2)	52 (37.7)	1.99 (0.88)
12	Collect or hoard items of any sort? N = 135	97 (71.9)	26 (19.3)	12 (8.9)	1.37 (0.64)
Section 3	Does Your Child	Never or Rarely, n (%)	Mild or Occasional (Does Not Affect Others), n (%)	Marked or Notable (Affects Others on a Regular Basis), n (%)	Mean (SD)
13	Insist on things at home remaining the same? (e.g., furniture staying in the same place, things being kept in certain places, or arranged in certain ways?) N = 139	109 (78.4)	23 (16.5)	7 (5.0)	1.27 (0.55)
14	Get upset about minor changes to objects (e.g., flecks of dirt on his clothes, minor scratches on toys) N = 139	121 (88.1)	13 (9.4)	5 (3.6)	1.17 (0.46)
15	Insist that aspects of daily routine must remain the same? N = 138	99 (71.7)	24 (17.4)	15 (10.9)	1.39 (0.68)
16	Insist on doing things in a certain way or re-doing things until they are "just right"? N = 139	98 (70.5)	29 (20.9)	12 (8.6)	1.38 (0.64)

(Table continues)

Table 1. Continued

Section 4	Does Your Child	Never or Rarely, n (%)	Mild or Occasional (Will Tolerate Alternatives When Necessary), n (%)	Marked or Notable (Will Not Tolerate Any Alternatives), n (%)	Mean (SD)
17	Play the same music, game or video, or read the same book repeatedly? N = 139	44 (31.7)	69 (49.6)	26 (18.7)	1.87 (0.70)
18	Insist on wearing the same clothes or refuse to wear new clothes? N = 138	135 (97.8)	3 (2.2)	0 (0.0)	1.02 (0.15)
19	Insist on eating the same foods, or a very small range of foods, at every meal? N = 139	103 (74.1)	24 (17.3)	12 (8.6)	1.35 (0.63)
Section 5		A Range of Different and Flexible Self-Chosen Activities, 1, n (%)	Some Varied and Flexible Interests But Commonly Chooses the Same Activities, 2, n (%)	Almost Always Chooses From a Restricted Range of Repetitive Activities, 3, n (%)	Mean (SD)
20	What sort of activity will your child choose if they are left to occupy themselves? N = 138	69 (50.0)	58 (42.0)	11 (8.0)	1.58 (0.64)

^aParents were asked to rate repetitive behaviors shown over the last month. ^bTwo response options were originally offered. These were “15 or more times daily (or at least once an hour)” and “30 or more times daily (or at least twice an hour).” Response data were subsequently collapsed for analyses to make means and SDs comparable across the questionnaire.

the scores are higher on the repetitive movements scale, than on the other scales ($F_{(3,414)} = 149.92, p < .001$).

To investigate the different subscale patterns and relations with gender, a series of mixed subscale \times gender analysis of covariances were performed with socioeconomic status as a covariate. Socioeconomic status was included as a covariate to control for possible effects on maternal reports of restricted and repetitive behaviors. For the two-factor model, there was a significant main effect of subscale, $F_{(1,136)} = 50.71, p < .001$, because the score on the motor-sensory subscale was significantly higher than the score for the rigidity/routines/preoccupations subscale, $t_{(138)} = 15.03, p < .001$. There was no significant effect of gender, $F_{(1,136)} = 0.03$, not significant, and no interactions between subscale \times gender, $F_{(1,136)} = 0.16$, not significant. For the four-factor model, there was a significant main effect of subscale, $F_{(1,136)} =$

40.55, $p < .001$. The score on the motor subscale was significantly higher than the score for the rigidity subscale, $t_{(138)} = 16.50, p < .001$, the preoccupation subscale, $t_{(138)} = 5.25, p < .001$, and the sensory subscale, $t_{(138)} = 11.84, p < .001$. The score on the preoccupation subscale was significantly higher than the score for the rigidity subscale, $t_{(138)} = 16.82, p < .001$, and the sensory subscale, $t_{(138)} = 12.48, p < .001$. There was also a significant difference between the scores on the rigidity and sensory subscales, $t_{(138)} = 6.08, p < .001$, with greater frequency of sensory scores. There was no significant effect of gender, $F_{(1,136)} = 1.10$, not significant, but there was an interaction between subscale \times gender, $F_{(1,136)} = 5.61, p < .02$. Follow-up independent t tests showed boys were showing greater frequency of sensory restricted and repetitive behaviors compared with girls, $t_{(137)} = 2.38, p < .02$.

Table 2. Mean Score for Total Repetitive Behaviors and Two- and Four-Factor Subscales

Variable	Mean	SD
Total repetitive behaviors	1.69	0.33
Two-factor subscales		
Motor/sensory	1.89	0.46
Rigidity/routines/preoccupations	1.35	0.35
Four-factor subscales		
Repetitive movements	2.09	0.58
Rigidity	1.35	0.35
Preoccupation	1.82	0.39
Sensory	1.54	0.36

Repetitive Behavior Questionnaire-2 Reliability at 15 Months

The internal consistency of responses on all items in the Repetitive Behavior Questionnaire-2 was high (Cronbach's $\alpha = 0.85$). With respect to the Leekam et al's subscales, both of the two-factor subscales showed good reliability (Cronbach's $\alpha = 0.81$ and $\alpha = 0.71$ for motor-sensory and rigid/routines/preoccupations, respectively), whereas for the four-factor subscale, only the repetitive movements subscale and rigidity subscale showed good internal consistency in this sample (Cronbach's $\alpha = 0.82$ and $\alpha = 0.74$, respectively), with the preoccupation and unusual sensory interest scales showing acceptable levels of reliability (Cronbach's $\alpha = 0.64$ and $\alpha = 0.51$, respectively). These results provide evi-

dence that the Repetitive Behavior Questionnaire-2 provides a reliable indication of total repetitive behaviors in children of this age group when using either the total restricted and repetitive behavior score or the two-factor subscales previously identified by Leekam et al.

DISCUSSION

The aim of this study was to describe the frequency of restricted and repetitive behaviors (RRBs) and the pattern of the predominant subtypes of these behaviors at 15 months of age. We found that the mean repetitiveness score for 15-month-old infants was at a higher level than the score reported in published studies of 2 year olds (mean total repetitiveness score = 1.69, SD = 0.33, compared with mean = 1.54, SD = 0.32). In particular, the score on the motor subscale scores was high compared with the level reported in previous published studies of 2 year olds (mean motor subscale score = 2.09, SD = 0.58, compared with mean = 1.52, SD = 0.48). Scores on other subscales were similar. Analysis of the subtypes of behavior also showed that parents of 15 month olds reported more frequent motor RRBs than any other subtype. This was the case at the subscale level analysis and also in individual item analyses. In contrast, previous research indicates that the most prevalent subtype of RRBs at 2 years was for more frequent preoccupation with restricted interests. This suggests that as children move from the second to the third year of life, the main focus of their RRBs changes from stereotypes to preoccupations with restricted interests.

These findings extend the work of Thelen^{1,2} who found that a range of rhythmic stereotypies were common in typically developing (TD) infants from 2 to 12 months. The current study is the first to consider RRBs in TD infants between 12 and 18 months, with the exception of the study by Iverson et al,⁸ which followed up children from 5 to 14 months of age, with a follow-up at 18 months. Iverson et al found that TD infants showed a peak of arm and finger rhythmicities during this period. However, the Iverson et al's study had a very small sample of TD infants and was an observational study limited to considering only motor stereotypies. Therefore, this current study makes an important contribution to the literature by investigating a wide range of RRBs in a large sample in the second year of life. This is likely to coincide developmentally with increasing voluntary control of motor behaviors and goal-driven behaviors.

Previous research has shown that high-risk siblings of Autism Spectrum Disorder (ASD) individuals show greater frequency of motor stereotypies, including arm/finger movements, in the second year of life compared with controls.^{8,9} This suggests that despite the frequency of motor RRBs in TD children at this age, it is possible to detect potential difficulties. This is in contrast, however, to the work of Werner et al,¹⁷ which reported a lack of stereotyped/repetitive behaviors in TD children until age 2 years and a lack of difference in motor RRBs at 15 months between ASD individuals and controls. It is pos-

sible to reconcile the results because the Werner et al's study was retrospective when children were aged 3 to 4 years. It may be that parents of TD children whose RRBs had then subsided may have had difficulty recalling such behaviors, whereas parents of ASD children may have been ready to report such stereotypies as they were still ongoing.

A secondary aim of this study was to investigate the reliability of the Repetitive Behavior Questionnaire-2 at 15 months for both the overall score and the two- and four-factor subscales identified in the Leekam et al's study. The Repetitive Behavior Questionnaire-2 was shown to be a reliable instrument for use with children of this age. The Cronbach's α for the total scores and two subscales identified by Leekam et al's were good. The alphas for some of the four subscales were acceptable, and this result may have been because of low levels of endorsement for a number of items on the sensory and preoccupation subscales. These items included "Insistence on wearing the same clothes," which may not be developmentally age appropriate and may only become important in the later preschool years. Other research with 2-year-old TD children has also found routines and rituals to be rare at a young age.^{23,24} It is possible that it may be appropriate to exclude such items from infant versions of the Repetitive Behavior Questionnaire-2 and include them in a later preschool version. These results together suggest that the total RRB score and motor-sensory and rigid/routines/preoccupations subscales can be reliably used as early as 15 months of age. However, the four-factor subscales are not recommended for this age group because of the lower levels of reliability.

Analyses were also performed to investigate relations with gender, because maternal reports of RRBs have been shown previously to relate to child gender. Results showed that there was no main effect of gender but there was an interaction with subscale at 15 months, with boys showing greater frequency of sensory RRBs. In previous research, Leekam et al¹⁸ found a difference using the Repetitive Behavior Questionnaire-2 in a TD sample, with boys showing higher levels of total RRBs at age 2 years. Similarly, Allison et al¹⁵ found a small but significant sex difference in a control group on the Q-CHAT measure, with boys showing more rigid and repetitive behaviors than girls at 18 to 24 months of age. Previous research by Deloache et al¹² focussing on one type of RRBs, extreme intense interests, found these were influenced by gender in early childhood. Gender of the child was related to the frequency and intensity of the extreme intense interests, with boys being more likely to have extreme intense interests, and their extreme intense interests were rated as more extreme. Together, these results suggest that gender differences in RRBs may be related to specific subscales at different ages, with boys showing more frequent behaviors.

The findings reported here may provide baseline comparison data for other studies involving at-risk and TD

samples. It may be particularly useful to gauge the developmental significance of behaviors that are seen more frequently in children who are subsequently diagnosed with ASD. Currently, we know little about the developmental mechanisms that create an atypical trajectory for children with ASD. According to Thelen,² RRBs provide a transitional state between uncoordinated motor activity and goal-directed behavior, which is perhaps why there were such high rates of behaviors in this study such as pacing and actions on objects, as these are among the major developmental achievements at 15 months of age. In the first year of life when motor stereotypies are common, they may easily be triggered; later, when goal directed behaviors are common, then more extremes of arousal (low or high) will be required to release such behaviors. Following Thelen's analysis, it is helpful to think of RRBs such as motor stereotypies at older ages as immature responses that are maintained inappropriately in the behavioral repertoire. These behaviors can be considered as an imbalance between inner state of arousal and the environment, and it is necessary for future research to consider how such imbalance occurs and why RRBs rather than goal-directed actions are selected.

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