



## Stereotypy in young children with autism and typically developing children<sup>☆</sup>

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### Abstract

Although stereotypy is one of the key diagnostic features of autism, few studies have compared stereotypic behavior in children with autism and typically developing children. The present study employed direct observational measurement methods to assess levels of stereotypic behavior in 2-, 3- and 4-year-old children with autism or pervasive developmental disorder – not otherwise specified (PDD-NOS) and age-matched typically developing peers. Thirty children with autism or PDD-NOS and 30 typically developing children participated. Each child's performance of several early learning and play skills was assessed using a direct observational assessment protocol developed for children with autism who were entering early intensive behavioral treatment. Duration of episodes of vocal and motor stereotypy was recorded from a videotaped 10 min portion of that assessment session. Results indicated that the 2-year-old children with autism or PDD-NOS had somewhat higher levels of stereotypic behavior than the typically developing 2-year-olds, while the 3- and 4-year-old children with autism or PDD-NOS displayed substantially higher levels stereotypic behavior than their same-age peers.

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Studies of intensive behavior analytic intervention for children with autism and pervasive developmental disorder-not otherwise specified (PDD-NOS) have documented large gains in many children who began treatment during their preschool years (e.g., [Anderson, Avery](#),

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DiPietro, Edwards, & Christian, 1987; Birnbrauer & Leach, 1993; Fenske, Zalenski, Krantz, & McClannahan, 1985; Harris & Handleman, 2000; Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Lovaas, 1987; McEachin, Smith, & Lovaas, 1993; Smith, Groen, & Wynn, 2000; Weiss, 1999). Improvements in cognitive, language, and social behaviors have been documented using measures such as standardized intelligence tests, language assessments, and adaptive behavior scales. Some studies reported that most comparison group children with autism or PDD-NOS who did not receive intensive behavior analytic treatment made smaller gains (e.g., Birnbrauer & Leach, 1993; Howard et al., 2005; Lovaas, 1987; Smith, Groen, & Wynn, 2000). Few of the published studies, however, reported details of improvements in specific categories of behavior, such as stereotypy or play.

Several variables may influence long-term treatment outcomes for children with autism or PDD-NOS. One is the age at which a child enters treatment. As noted previously, the best outcomes documented to date have been attained by children who entered intensive behavior analytic treatment prior to the age of 5 years (see Green, 1996 for a review). Few studies have examined the relation between age at treatment entry and outcome directly, but Fenske, Zalenski, Krantz, and McClannahan (1985) reported that children who began intensive behavior analytic treatment prior to 60 months of age were more likely to live at home and be enrolled full time in a public school after 2 years of treatment than were children who entered treatment after 60 months of age. Harris and Handleman (2000) found that children who began intensive treatment at 3 years of age were more likely to be placed in an integrated educational setting after 2 years of intervention than children who began treatment at ages 4 and 5 years.

A largely unexamined factor that may influence long-term treatment outcomes for children with autism or PDD-NOS is the extent to which children engage in stereotypy before, during, and after treatment. Stereotypic behavior is defined as repetitive motor and vocal responses that serve no obvious adaptive function (LaGrow & Repp, 1984; Matson, Kiely, & Bamburg, 1997; Smith & Van Houten, 1996). Although stereotypy occurs in individuals with mental retardation and other disorders (Bodfish et al., 1995; Matson et al., 1997; Rojahn, Matlock, & Tasse, 2000), it is considered a key diagnostic feature of autism (American Psychiatric Association, 1994; Lewis & Bodfish, 1998). Stereotypic behaviors have been shown to interfere with acquisition of new skills (Dunlap, Dyer, & Koegel, 1983; Epstein, Doke, Sajwaj, Sorell, & Rimmer, 1974; Koegel & Covert, 1972; Morrison & Rosales-Ruis, 1997), can decrease the likelihood of positive social interactions (Wolery, Kirk, & Gast, 1985), and can be stigmatizing (Jones, Wint, & Ellis, 1990). Stereotypy, therefore, has been the focus of behavioral intervention as well as considerable research over the past 20 years (e.g., Berkson & Tupa, 2000; Berkson, Tupa, & Sherman, 2001; Hanley, Iwata, Thompson, & Lindberg, 2000; LaGrow & Repp, 1984; Lewis & Bodfish, 1998).

Researchers have examined a variety of factors associated with stereotypic behavior in individuals with autism. A series of comparison studies revealed that individuals with autism had higher levels and intensity of stereotypy than individuals with mental retardation (Bodfish, Symons, Parker, & Lewis, 2000). Lower scores on the Vineland Adaptive Behavior Scale have been found to be correlated with higher levels of stereotypic behavior (Matson et al., 1997), as have low IQ and certain co-morbid conditions (Lewis & Bodfish, 1998; Rojahn, Matlock, & Tasse, 2000). In most studies, stereotypy was measured indirectly (i.e., with checklists and rating scales) rather than with direct observational measurements (Lewis & Bodfish, 1998).

Repetitive, stereotypic behavior has also been documented in the repertoires of typically developing infants and children (e.g., Foster, 1998; Troster, 1994), but it becomes less varied and less frequent with age (Thelan, 1979) and occurs principally during certain types of activities

(Foster, 1998). Relatively few studies have compared the stereotypic behavior of developmentally disabled children with that of age-matched typically developing peers. One set of investigators noted differences in the topographies and duration of stereotypic behavior in samples drawn from those two populations (Schwartz, Gallagher, & Berkson, 1986). Another study compared stereotypic behavior in typical children and children with developmental disabilities ages 10–15 years. The children with developmental disabilities exhibited higher rates of stereotypic behavior than chronologically age-matched peers, but similar rates as mental age-matched peers (Smith & Van Houten, 1996). The authors of that study measured stereotypy via repeated direct observations, but they used a discontinuous, partial-interval recording method, which tends to overestimate the actual levels of behavior like stereotypy (Gardenier, MacDonald, & Green, 2004; Murphy & Goodall, 1980).

Most published studies of stereotypy in typically developing as well as developmentally delayed children have attempted to measure stereotypic behavior indirectly by having caregivers or other observers complete questionnaires, checklists, or rating scales (see Lewis & Bodfish, 1998). Results have often been reported as estimated mean prevalence rates. Direct and continuous measurement of duration of episodes of stereotypy, aggregated across individual children, could yield data that are both more precise and more rich than those produced by indirect measures. A comparison of levels of stereotypic behavior in young children with and without autism of various ages could shed light on the developmental course of this behavior. Specifically, comparing levels of stereotypy in children of different preschool ages could help pinpoint the age at which the stereotypic behavior of young children with and without autism begins to differentiate. We undertook such a study, using continuous direct observational measurement methods to compare levels of vocal and motor stereotypy in 2-, 3- and 4-year-old children with autism or PDD-NOS and typically developing age-matched children.

## 1. Method

### 1.1. Participants

Sixty children participated. Thirty were diagnosed with autism or PDD-NOS, and 30 were typically developing. Within each group there were 10 2-year-olds, 10 3-year-olds, and 10 4-year-olds. The mean chronological age for the children with autism in the 2-year-old group was 30 months (range: 24–35 months); in the 3-year-old group, the mean was 41 months (range: 37–47 months); and the mean for the 4-year-old group was 53 months (range: 49–59 months). The mean chronological age for the typically developing children in the 2-year-old group was 31 months (range: 27–34 months); in the 3-year-old group, the mean was 41 months (range: 37–47 months); and the mean for the 4-year-old group was 53 months (range: 50–59 months).

All children with autism or PDD-NOS were recently enrolled in the preschool or home-based components of the New England Center for Children's Intensive Instruction Program, an intensive behavior analytic treatment program. They had been diagnosed by community professionals who were not associated with the treatment program. These children had no previous exposure to intensive behavior analytic treatment. The typically developing children were enrolled in an on-site daycare preschool classroom run by the New England Center for Children (NECC). These children were selected for participation solely on the basis of chronological age, matched within 4 months to the participants with autism or PDD-NOS. Consent was obtained for each child to participate in this study.

### 1.2. Assessment procedures

A portion of the NECC Early Core Skills Assessment battery was used for the current study. This is a direct observational assessment protocol designed to evaluate performances on a range of skills that are commonly targeted for early intervention with children with autism or PDD-NOS, including vocal and motor imitation, matching, receptive and expressive communication, and instruction-following skills (Anderson et al., 2000; Geckeler et al., 1998). Examiners were supervisors of the treatment program for the children with autism or PDD-NOS, but were not involved in delivering treatment on a daily basis. They were trained to adhere to the assessment protocol with high accuracy and reliability before administering the battery. Each child was given the entire battery, but only a 10 min sample of each child's assessment session was used for this study (5 min of "free play" and 5 min of structured assessment trials). The assessment battery was administered to all children with autism or PDD-NOS within 6 months after they entered the NECC Intensive Instruction Program. All of the typically developing children were assessed during the same school year.

All assessment sessions were conducted in a small testing room containing a child-sized table and two chairs, a bookcase with toys and books, and a video camera on a tripod. During the play portion of the assessment, the child was instructed to play with the toys in the room but was allowed to move anywhere in the testing room. The child was not prompted to play after the initial instruction. During the structured assessment trials the child and the examiner sat facing one another knee to knee. This part of the assessment included sub-tests for motor imitation, vocal imitation and answering social questions. Stereotypy was not interrupted or redirected at any time during the play period or the structured assessment trials. Assessment sessions generally lasted approximately 30 min. All sessions were videotaped.

### 1.3. Dependent measures

Duration of all episodes of motor and vocal stereotypy was recorded from the videotaped samples. Operational definitions are in [Appendix A](#); they were the same definitions used by Gardenier, MacDonald, and Green (2004). The first 10 min of each sample was scored using a "real-time" measurement method described by Miltenberger, Rapp, and Long (1999). The duration of each episode of stereotypy was recorded second by second using the timer shown on the video screen, yielding a record of all 600 s of each 10 min sample. The percent duration of motor and vocal stereotypy was calculated by summing the duration of all episodes of each respectively, dividing by 600 s (the total sample time), and multiplying by 100%. Total stereotypy was calculated by summing the percent durations of motor and vocal stereotypy.

### 1.4. Interobserver agreement

An independent observer scored the first 3 min of each sample for comparison with the scoring of the primary data collector. An agreement was defined as identification of the onset and offset of an episode by both observers within 1 s of each other. All overlapping seconds were considered agreements. Interobserver agreement (IOA) was calculated by dividing the number of agreements by the number of agreements + disagreements and multiplying by 100%. For the samples of the stereotypic behavior of children with autism or PDD-NOS, overall mean IOA for motor stereotypy was 95% (range: 87–100%) and overall mean IOA for vocal stereotypy was 95% (range: 82–100%). For the samples of the behavior of the typically developing children,

overall mean IOA for motor stereotypy was 96% (range: 85–100%) and overall mean IOA for vocal stereotypy was 96% (range: 85–100%).

## 2. Results

Descriptive analyses were performed to examine the mean percent duration of stereotypy for children with autism or PDD-NOS and typically developing children in each age group. **Table 1** shows the mean percent duration of total, motor, and vocal stereotypy by age at assessment for both groups of participants. For the typically developing children, the mean duration of total stereotypy for all three age groups ranged from 3 to 5%. The mean percent duration of total stereotypy for the children with autism or PDD-NOS was 12% for the 2-year-olds, 23% for the 3-year-olds, and 39% for the 4-year-olds. For the typically developing children, the mean durations of motor stereotypy were 5% for the 2-year-olds, 3% for the 3-year-olds, and 2% for the 4-year-olds. For the 2-, 3- and 4-year-olds with autism or PDD-NOS, means were 7% (range: 0–13%), 13% (range: 3–22%), and 20% (range: 1–44%), respectively. For the typically developing children, the mean durations of vocal stereotypy were 4% for the 2-year-olds, 3% for the 3-year-olds, and 2% for the 4-year-olds. For the 2-, 3- and 4-year-olds with autism or PDD-NOS, means were 5% (range: 0–12%), 12% (range: 2–23%), and 22% (range: 9–43%), respectively.

The results summarized in **Table 1** are depicted graphically in **Fig. 1**. On average, stereotypy increased with age in our samples of children with autism or PDD-NOS, and stayed the same or decreased slightly with age for the typically developing children in this study. The difference between children with autism or PDD-NOS and typically developing children was greatest at age 4, but some difference was evident at age 2.

For total stereotypy, the data obtained with each individual are depicted in **Fig. 2**. The percent duration of stereotypy for the typically developing children ranged from 0 to 9% for 2-year-olds, 0 to 27% for 3-year-olds, and 0 to 8% for 4-year-olds. The percent duration of stereotypy for children with autism or PDD-NOS ranged from 5 to 18% for 2-year-olds, 5 to 36% for 3-year-olds, and 14 to 61% for 4-year-olds.

To examine the effect of age on stereotypic behavior in children with autism or PDD-NOS, a single factor ANOVA was performed, as shown in **Table 2**. Differences in mean durations of motor, vocal, and total stereotypy among the three age groups were statistically significant. Post hoc tests, also shown in **Table 2**, were performed to evaluate differences between the means for the three age

**Table 1**  
Mean durations of stereotypy by age group

Age (years)	DX	Total		Motor		Vocal	
		Duration <sup>a</sup> (s)	Duration <sup>b</sup> (%)	Duration (s)	Duration (%)	Duration (s)	Duration (%)
2	Autistic	70.3	11.7	41.2	6.9	30.7	5.1
	Typical	26.3	4.4	28.7	4.8	2.6	0.4
3	Autistic	139.7	23.3	80.2	13.4	72.7	12.1
	Typical	30.2	5.0	19.5	3.3	10.5	1.8
4	Autistic	232.5	38.8	120.9	20.2	133.7	22.3
	Typical	18.4	3.1	12.4	2.1	6.1	1.0

<sup>a</sup> Duration in seconds represents the total duration within a 10 min sample.

<sup>b</sup> Percent duration is calculated as the sum of the duration of all episodes divided by the total sample time of 600 s multiplied by 100%.

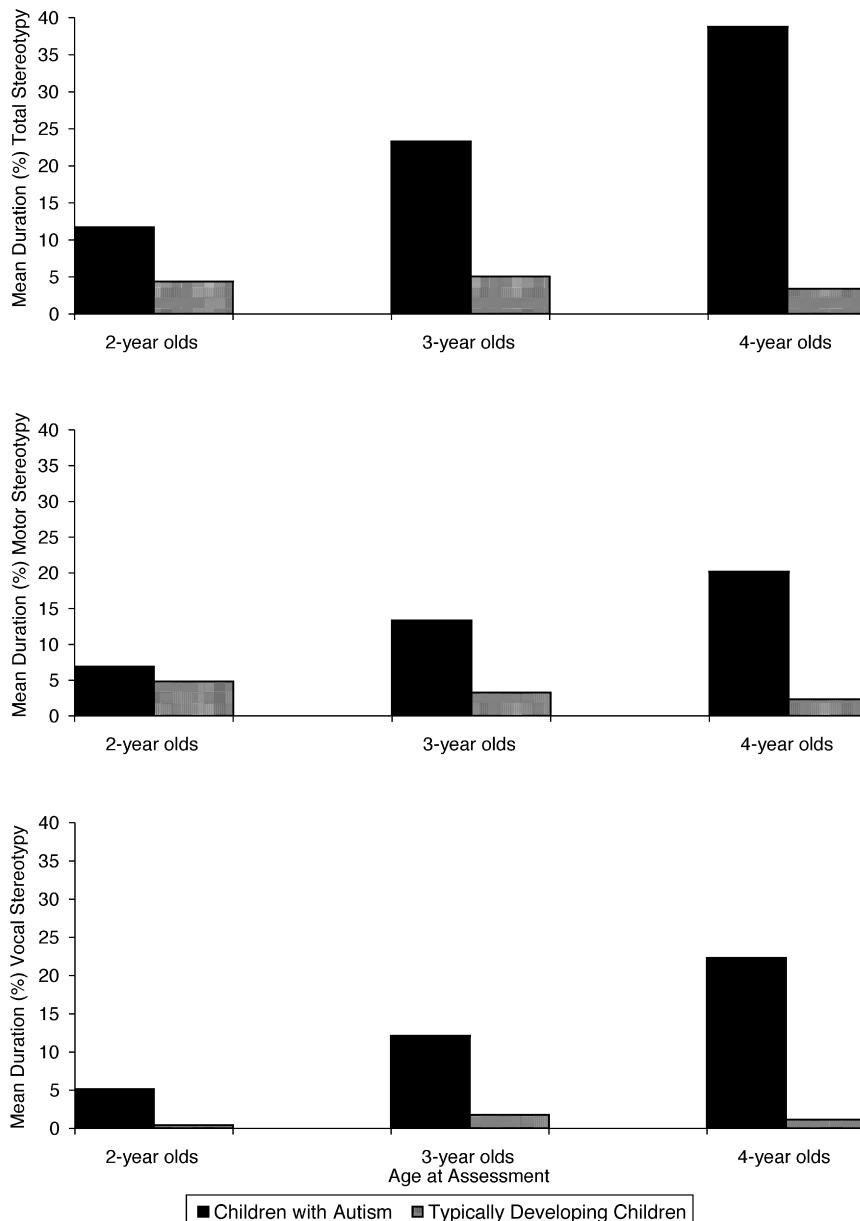


Fig. 1. Top graph: mean percent duration of all stereotypy (vocal and motor stereotypy combined) for the typically developing children (striped bars) and the children with autism or PDD-NOS (open bars) by age group. Middle graph: mean percent duration of motor stereotypy for the typically developing children (striped bars) and the children with autism or PDD-NOS (solid bars) by age group. Bottom graph: mean percent duration of vocal stereotypy for the typically developing children (striped bars) and the children with autism or PDD-NOS (solid bars) by age group.

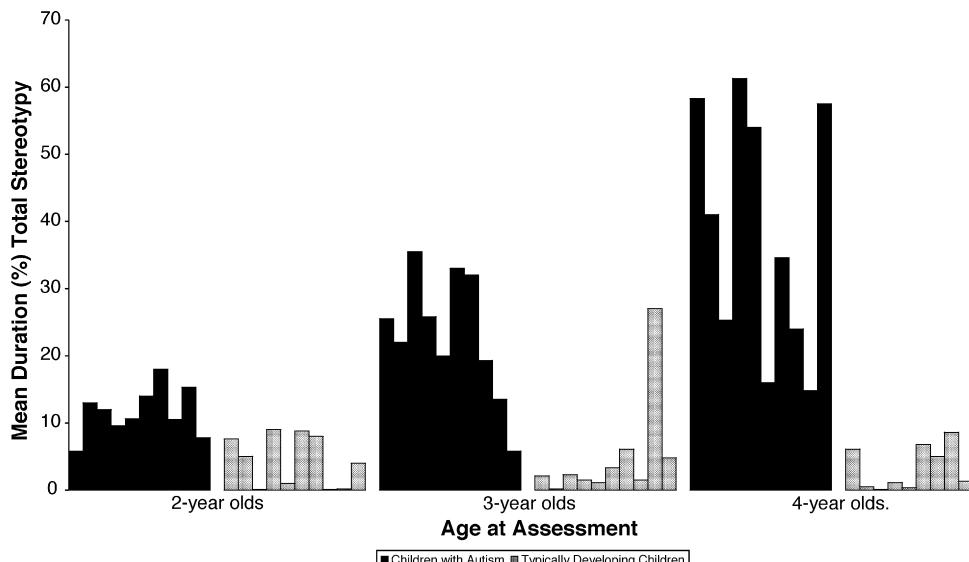


Fig. 2. Individual participant data showing percent duration of all stereotypy (vocal and motor stereotypy combined) for the typically developing children (striped bars) and children with autism or PDD-NOS (solid bars) by age group.

groups of children with autism or PDD-NOS. The multiple *t* LSD test was used to control the comparison-wise error rate, and the Bonferroni (Bon) test was used to control the experiment-wise error rate. The differences among groups for both tests were evaluated at the 0.05 level. For total stereotypy, differences among all age-group means for the children with autism or PDD-NOS were significant according to the LSD, while the Bon indicated significant differences between the mean for the 4-year-olds and the other two age groups for total and vocal stereotypy. For motor stereotypy, both tests showed the mean for the 4-year-olds with autism or PDD-NOS to be significantly different from the mean for the 2-year-olds with autism or PDD-NOS, but no significant differences were found when the means for these youngest and oldest groups were compared with the mean for the 3-year-olds with autism or PDD-NOS. In sum, the ANOVA and the associated post hoc tests found statistically significant differences in the mean levels of stereotypic behavior in the three age groups of the children with autism or PDD-NOS, despite the limited sample sizes.

### 3. Discussion

The duration of stereotypic behavior in our samples of young children with autism or PDD-NOS who were just entering early behavioral intervention and in our samples of typically

Table 2

Statistical comparisons of mean durations of stereotypy in children with autism or PDD-NOS by age group

	Total	Motor	Vocal
One-way ANOVA	Pr > <i>F</i> 0.0001	Pr > <i>F</i> 0.0163	Pr > <i>F</i> 0.0001
Multiple <i>t</i> -test LSD	0.05 all ages differ	0.05 age 4 differs from age 2	0.05 all ages differ
Bonferroni <i>t</i> -tests	0.05 age 4 differs from ages 3 and 2	0.05 age 4 differs from age 2	0.05 age 4 differs from ages 3 and 2

developing children clearly diverged at the age of 2 years. The difference was larger at age 3, even more substantial at age 4. In fact, the 4-year-old children with autism or PDD-NOS exhibited substantially higher mean durations of stereotypic behavior than the 2- and 3-year-old children with autism or PDD-NOS as well as the typically developing 4-year-olds. These findings are consistent with those of other studies that have reported higher levels of stereotypy in individuals with disabilities than in age-matched individuals without disabilities (e.g., Smith & Van Houten, 1996). Our study appears to be the first, however, to pinpoint the age at which that difference emerges in children with autism or PDD-NOS with data from continuously measured direct observational samples of stereotypic behavior, as opposed to indirect methods, such as caregiver reports, and estimates derived from discontinuous measurement, such as partial-interval recording.

Stereotypic behavior was observed to occur at comparably low levels in all three of our age-group samples of typically developing children, whereas levels increased with age in the children with autism and PDD-NOS. These data suggest that the goal of reducing stereotypic behavior in young children with autism or PDD-NOS has habilitative validity (Hawkins, 1991), in that age-matched norm groups of 3- and 4-year-olds in this study exhibited considerably less stereotypy than same-age children with autism or PDD-NOS who were just entering behavioral intervention. Our results also converge with other findings to suggest that 2 years or younger might be the optimal age at which to begin treatment with children with autism and related developmental disorders, because after the age of 2 such children allocate increasing amounts of time to stereotypic and other interfering behavior if they do not receive effective intervention to develop more age appropriate play and other adaptive skills (Berkson & Tupa, 2000).

The 4-year-old children with autism or PDD-NOS in our sample had the highest durations of all types of stereotypy, but the most striking differences were observed in vocal stereotypy. For example, our 2-year-old children with autism or PDD-NOS and virtually all of the typically developing youngsters had low durations of vocal stereotypy, while some of the 4-year-old children with autism or PDD-NOS exhibited durations of over 40%. Further, informal observations suggested two characteristic differences in the topography of the vocalizations of the 4-year-olds with and without autism or PDD-NOS. The typically developing children tended to emit contextually appropriate and clearly identifiable words, frequently commented on things in their environment, and often addressed vocalizations to the examiner while making eye contact. The vocalizations of the 4-year-olds with autism or PDD-NOS, on the other hand, were typically repetitive noises or non-contextual phrases, and were rarely paired with eye contact or orientation toward the examiner. These observations suggest that reducing vocal stereotypy and developing functional verbal behavior are particularly important treatment goals for young children with autism or PDD-NOS.

The external validity of our study is limited by the relatively small number of participants in each sample. Whether the findings extend to other preschool children with and without autism or PDD-NOS remains to be seen, but it is assumed that the obtained results are generally representative. Additionally, the data on the children with autism or PDD-NOS were recorded during initial assessment sessions, when the children were just entering intensive behavioral treatment at the ages of 2–4 years. Because this was a cross-sectional descriptive study, no inferences should be drawn regarding changes in stereotypic behavior over the course of intervention or over the course of development without specific intervention. For example, the levels of stereotypy exhibited by the 4-year old children with autism or PDD-NOS in our sample when they were 2 years of age are not known.

Another limitation is that our results are based on one 10 min sample of behavior for each child. Since stereotypy can vary greatly across settings and time, multiple repeated samples might

have resulted in different findings. On the other hand, given the standardized conditions under which stereotypy was assessed in this study, the data were generally consistent across participants within each age group. Further, most standardized tests and observational assessments used with children with autism or PDD-NOS take only brief, limited samples of behavior in each domain they purport to assess, and few of them sample stereotypic behavior. We suggest that brief samples of stereotypic behavior obtained through continuous direct observational measurement are better than indirect, subjective measures, such as caregiver reports, estimates derived from discontinuous measurement methods (e.g., whole- or partial-interval recording), or no measures at all, and that direct measurement of stereotypy should be included in both initial and ongoing assessments of the repertoires of young children with autism or PDD-NOS.

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## Appendix A. Operational definitions

### A.1. Motor stereotypy

#### A.1.1. Stereotypic responses (S)

Responses that have no apparent function and are not teacher-directed.

- Non-functional movement of any or all body parts including:
  - rocking or swaying of torso, head, feet or body in full motion (down and up or left and right), occurring at least twice in 2 s;
  - non-functional closing or squinting of eyes;
  - jumping: abrupt raising of body with or without feet leaving the floor, may be paired with movement forward or back; does not include skipping, galloping or dancing;
  - heel and toe walking;
  - pressing or rubbing fingers or whole hand against surface or body parts for more than 1 s;
  - tapping objects with a or own body finger or open hand more than two times in 2 s;
  - spinning or rotation of entire body more than two times in 2 s.
- Non-functional hand movements including:
  - hand flapping;
  - hand or finger posturing;

- non-contextual pointing;
- fanning or spreading of fingers;
- putting fingers in ears or mouth;
- non-functional rotation of hand (more than 90°) with or without materials;
- positioning hands in front of face or over ears;
- finger flicking.
- Non-functional manipulation of objects (inconsistent with intended function or manipulation of object)
  - spinning objects;
  - addition of objects to a line (two or more) objects;
  - licking, mouthing, or smelling objects, people or surfaces in a manner not appropriate to materials.

Non-examples include:

- “walking” toys (e.g., cars, stuffed animals, dolls);
- student rocking in one direction and teacher redirecting back;
- movements generated from an unobservable body part, i.e., legs wiggling but view on tape is from waist up;
- smiling that does not produce an audible sound;
- wiping face or mouth;
- incorrect responses to teacher direction (note that this is specific to the direction; e.g., only incorrect motor responses to cues meant to set the occasion for a motor response and incorrect vocal responses to cues meant to set the occasion for a vocal response are considered non-examples): does not include responses occurring continuously prior and during the instruction
- approximations of word or request;
- rubbing eyes, scratching skin;
- bearing weight elbow, forearm or fist;
- tapping anywhere on teacher’s body to get attention;
- immediate echolalia: words identical to those spoken by another person;
- throwing objects;
- stretching (full extension) of legs or arms while seated.

## A.2. Vocal stereotypy

### A.2.1. Stereotypic responses (S)

Responses that have no apparent function and are not teacher-directed.

Examples include:

- vocalizations that are not recognizable words (in normal conversational tone and volume) and are not in direct response (within 5 s) to teacher request for vocal response;
- non-contextual laughing or giggling (not in response to interaction with materials or interaction with another person);
- non-contextual words or phrases. Ex.: During a math class, student asks “Where did you buy your shirt?” Student is playing with a toy train, produces sound of dog barking;
- repetition of phrase within 5 s – score second instance as stereotypy.

Non-examples include:

- whispering;
- whining—high pitched prolonged vocalization;
- crying;
- screaming, vocalizations above normal conversation level;
- laughing in response to tickling or joke;
- noises associated with a play action: saying “neigh” while walking horse, saying “boom” when two toy cars hit each other;
- smiling that does not produce an audible sound;
- incorrect responses to teacher direction (note that this is specific to the direction; e.g., only incorrect motor responses to cues meant to set the occasion for a motor response and incorrect vocal responses to cues meant to set the occasion for a vocal response are considered non-examples);
- approximations of word or request;
- immediate echolalia: words identical to those spoken by another person;
- repetition of word or phrase in attempt to gain teacher attention or response.

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