A Direct Comparison of Self-Injurious and Stereotyped Motor Behavior Between Preschool-Aged Children With and Without Developmental Delays

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Abstract

Objective To compare the prevalence of self-injurious behavior (SIB) and stereotyped motor behavior (STY) of preschool-aged children with developmental delays (DD group) and their peers without developmental delays (TD group) using a standardized caregiver report scale.

Methods The Repetitive Behavior Scale-Revised was completed by caregivers of children with developmental delays and their peers without developmental delays. Frequency of occurrence and severity ratings for SIB and STY were compared between groups.

Results SIB and STY were reported more often and at a greater level of severity in the DD group. Older chronological age was associated with more severe STY in the DD group but not the TD group. Gender was not related to STY or SIB for either group.

Conclusions Differences in STY and SIB were evident between preschoolers with and without DD. Findings are discussed from developmental and behavioral psychology perspectives regarding the expression of repetitive behavior in developmentally at-risk pediatric populations.

Key words: developmental delay; intellectual disability; self-injurious behavior; stereotyped behavior.
sequence/progression of rhythmic motor behavior. Based, in part, on this work, early stereotyped motor movement has been conceptualized as a behavioral precursor to SIB, such that some forms of SIB are preceded in development by stereotyped motor behavior (STY; Guess & Carr, 1991). The work of Berkson and colleagues represents this line of thought, and resulted in a set of studies providing estimates of the prevalence of SIB in young children with significant developmental disabilities (Berkson, 2002; Berkson & Tupa, 2000; Berkson, Tupa, & Sherman, 2001). There have also been behavioral studies applying operant learning models to SIB in young children, in which SIB and STY are studied in relation to immediate contextual events and social learning mechanisms (Oliver, Hall, & Murphy, 2005; Richman & Lindauer, 2005).

Only three published studies directly compare the repetitive motor behavior of young children with and without developmental concerns. Kravitz and Boehm (1971) compared the onset of hand-to-mouth sucking in 140 typical newborn infants and in 79 infants with perinatal abnormalities (such as low birth weight, Apgar scores <6, respiratory distress, cerebral hemorrhage, or anoxia), though not specifically diagnosed with developmental delay. Hand sucking had a significantly delayed onset among the infants with perinatal abnormalities as compared with infants without abnormalities. In the same paper, Kravitz and Boehm observed similar differences in the mean age of onset for hand sucking between normal infants (<1 month of age) and those with Down syndrome (5 months of age).

A longitudinal study by MacLean, Ellis, Galbreath, Halpern and Baumeister (1991) compared the rhythmic motor behavior of children with Down syndrome (n = 7), motor impairments (n = 11), and typical development (n = 10) matched on motor age equivalent scores. The authors quantified rhythmic motor behavior using a coding system similar to Thelen (1979). Children were followed longitudinally for 9–14 months from a starting chronological mean age of 14.5 months for the children with Down and a mean age of 23.4 and 5.8 months for the children with motor impairments and typical development, respectively. The groups were compared on the number of bouts, and on the duration of seven subtypes of rhythmic motor behavior involving the head, mouth, arm, hand, torso, leg, and feet. Where differences were noted, the children with Down syndrome and/or motor impairments exhibited significantly more rhythmic motor behavior than the children with typical development.

Schwartz, Gallagher, and Berkson (1986) compared the occurrence of hand gazing and body rocking exhibited by typically developing infants and toddlers with those with severe intellectual disability. The children with severe intellectual disability spent significantly longer periods gazing at their hands and engaged in more body-rocking oscillations per bout and greater amplitude of body rocking than their typical peers.

Collectively, the research findings from these lines of inquiry have provided the following evidence. In typically developing infants, there is a predictable sequence of rhythmic motor development, which appears stereotypic and declines by 24 months of age (Thelen, 1979). This stereotypic, rhythmic motor behavior may appear at later ages in children with Down syndrome and those with significant motor impairment (Kravitz & Boehm, 1971; MacLean et al., 1991). Moreover, children with significant developmental disabilities engage in relatively high rates of STY as compared with typically developing infants and toddlers (Berkson et al., 2001; MacLean et al., 1991). Surprisingly, there are no published studies on the occurrence of SIB that directly compare young children with and without developmental delay of comparable chronologic age. Without such information, there is no basis for determining whether the occurrence of SIB among young children with developmental delay differs from that observed in the context of typical development. Moreover, use of a standardized instrument would permit comparisons of the severity of SIB among young children with and without developmental delay. Such information, if available for young children, would provide support for preventive interventions during the early developmental period.

The present descriptive study was designed to directly compare the parent-reported frequency of SIB and STY using the Repetitive Behavior Scale-Revised (RBS-R; Bodfish, Symons, Parker, & Lewis, 2000) between a community sample of typically developing children and an age-matched sample of children referred to a developmental behavioral pediatrics clinic based on parental and physician concerns about developmental delay. Specific objectives were to determine whether (a) SIB and STY varied with age within and/or between groups, (b) if there were gender differences associated with SIB and STY within and/or between groups, and (c) if SIB and STY were related to developmental level in the group with developmental delay.

**Method**

**Participants**

Two groups of preschool-aged children (n = 49) participated in this study—one with developmental delay (DD group) and one without developmental delay (TD group). The mean age of DD group was 37.5 months (SD = 13.2) and the mean age for the TD
group was 36.6 months (SD = 14.7). The groups did not differ significantly in chronological age (F(1, 96) = 0.12, p = .735), which ranged from 8 to 65 months for the DD group, and 16 to 81 months for the TD group. There were significantly more males in the DD group (82%) than the TD group (62%; X²(1) = 5.00, p < .05) consistent with previous reports that boys are at greater risk for developmental delay than girls (Boyle et al., 2011). Families were not asked to provide information on their child’s race or ethnicity but the population from which both samples were drawn is primarily White and Non-Hispanic (80%) (citation [removed for blind review]).

The developmental level of children in the DD group was ascertained using the Child Development Inventory (CDI; Ireton, 1992; described below). The DD group had a median general developmental quotient of 0.65 (general developmental level in months divided by chronological age in months). For comparison, a value of 1.00 would indicate that a child is at age level on this measure. Table I provides the means and standard deviations for the various CDI subscales for the DD group.

### Procedures

Convenience samples were recruited from two sources/sites. The “at risk for developmental delay” (DD) sample was formed by consecutive enrollment of families served by a developmental behavioral pediatrics clinic. These children were identified by early childhood professionals as part of a “child find” mandate for preschool screening, or were identified by their primary care physicians and referred to the developmental behavioral pediatrics clinic. None of the children were referred for evaluation because of concerns regarding stereotypy or self-injury. These children came to participate in the study through a typical pathway for standard practice in the area in which they live. On clinic enrollment, families completed an intake packet to obtain demographic and medical history information including the RBS-R (described below) and other developmental measures used in this study. For the sample of typically developing (TD) children, childcare center staff distributed RBS-R packets to all children who did not have an identified delay, disability, or chronic health condition that might affect development. A second wave of packets was distributed later, to oversample classrooms with children matched in age to DD participants not matched by respondents from the initial wave of recruitment. Childcare staff did not distribute packets to parents of children who had Individual Family Service Plans (which denotes special education services being provided for concerns related to development or related risk issues). Further, the center did not provide specialty services or staffing beyond those provided to typically developing children in daycare settings at the time of the study. Parents filled out and returned the RBS-R via U.S. Mail. There was a 34% response return rate for the TD sample. This study was approved by the University of Minnesota’s institutional review board, and informed consent was obtained from parents or guardians for all participants.

### Measures

#### Repetitive Behavior Scale-Revised

The RBS-R has 43 items, divided into six subscales: Stereotyped Behavior (STY), Self-Injurious Behavior (SIB), Compulsive Behavior, Ritualistic Behavior, Sameness, and Restricted Behavior (Bodfish et al., 2000). The STY subscale consists of six items regarding seemingly purposeless movements or actions that are repeated in a similar manner. The SIB subscale consists of eight items regarding actions that have the potential to cause redness or bruising to the body, and that are repeated in a similar manner (e.g., bangs head on the floor, bites hand, picks at the skin). Items are rated on a scale of 0 (behavior does not occur) to 3 (behavior occurs and is a severe problem). The RBS-R is commonly used in clinical settings and has shown validity and reliability for measuring repetitive behavior in young children with intellectual and developmental disabilities (Rojahn et al., 2013; Schroeder et al., 2014). For the purpose of this study, the SIB and STY subscales of the RBS-R were analyzed. Coefficient alpha reliabilities for both groups in the current study are reported in Table II.

### Child Development Inventory

The CDI contains 270 “yes/no” questions to obtain parent report of child development (Ireton, 1992). The CDI is typically used to evaluate children 15 months to 6 years old and yields developmental age-equivalent values in months. For the present study, those age equivalents were converted to developmental quotients...
by dividing the age equivalents by each child’s chronological age. Developmental quotients for gross motor, fine motor, expressive language, language comprehension, letters, numbers, and general development were used to describe the DD sample. The CDI’s developmental age estimate has been found in past research to have a strong correlation with other developmental tests (Petersen, Kube, Witaker, Graff, & Palmer, 2009).

Data Analysis
Two analysis of variance (ANOVA) models were tested to determine whether groups differed in parent-reported SIB or STY scores and whether these group differences were predicted by age category or by gender (entered as predictors in the ANOVA models). Within the DD group, Pearson correlations were used to determine whether general development, expressive language, and language comprehension were correlated with SIB/STY. The ANOVA models used total subscale scores (the sum of ratings for each subscale) as the dependent measure.

Results
Frequency and Severity
The occurrence of STY, defined as a rating of ≥1 for any of the STY subscale items, was reported for 85.7% of the DD group and 42.8% of the TD group. The difference in occurrence of STY between the groups was significant ($X^2 = 19.6, df = 1, p < .01$). The distribution of nonzero STY subscale ratings is presented in Figure 1a. Ratings of “moderate” or “severe” occurred with considerable frequency in the DD group, while no parent of a child in the TD group endorsed “moderate” or “severe” for any topographies of SIB. With a total of 392 possible endorsements per group (number of subscale items × number of participants), a Chi-square test of differences was conducted to determine whether the distribution of SIB ratings differed between the two groups. The result was significant ($X^2 = 43.8, df = 3, p < .001$) owing to the higher severity ratings for the DD group. The most common topography of SIB for the DD sample was “hits self against surface or object” (endorsed 19 times). The most common topography of SIB for the TD sample was “rubs or scratches self” (endorsed five times).

Between Group Analyses
STY subscale scores significantly differed between samples (DD > TD), $F(1, 96) = 18.11, p < .01, \eta^2 = .14$. The mean score for SIB in the DD sample was 4.10 ($SD = 3.51$) and 1.41 ($SD = 0.65$) in the TD sample. There was a significant age by group interaction, $F(4, 96) = 2.85, p < .042, \eta^2 = .12$. Follow-up Tukey $t$ tests indicated significant between group differences for the 36–48 month and the ≥48 month age cohorts. In both cases, the DD group had significantly higher STY subscale scores than the TD group. SIB subscale scores also significantly differed between groups, $F(1, 96) = 51.40, p < .01, \eta^2 = .452$ and no significant differences by age cohort or by gender (all $p > .51, \eta^2 < .02$) nor were there significant age cohort or gender by group interactions ($p > .452, \eta^2 < .03$) (see Table III for age cohort by group means).

Correlates With SIB and STY Within Developmental Delay Group
Pearson correlations were conducted to determine whether SIB and STY were correlated with general development and expressive or receptive language abilities based on the CDI. SIB was not significantly correlated with any CDI scales (all $p > .51, all r < .1$). This is consistent with recent research involving comparable samples of young children with developmental delay (MacLean & Dornbush, 2012; MacLean, Tervo, Hoch, Tervo, & Symons, 2010). STY was significantly correlated with expressive language ($r = .358, p < .013$) and

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Table II. Unweighted Coefficient Alpha for Repetitive Behavior Scale-Revised Stereotyped Behavior (STY) and Self-Injurious (SIB) Subscales by Group and Overall

<table>
<thead>
<tr>
<th></th>
<th>STY [95% CI]</th>
<th>SIB [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall sample</td>
<td>0.817 [0.77, 0.87]</td>
<td>0.757 [0.63, 0.88]</td>
</tr>
<tr>
<td>Children without developmental delay</td>
<td>0.684 [0.51, 0.86]</td>
<td>NA</td>
</tr>
<tr>
<td>Children with developmental delay</td>
<td>0.748 [0.66, 0.84]</td>
<td>0.735 [0.59, 0.89]</td>
</tr>
</tbody>
</table>

Note. Numbers in brackets represent 95% confidence interval for alpha. NA = insufficient replicated values to calculate alpha.
language comprehension ($r = .312, p < .033$) but not with general development ($r = .237, p > .10$).

**Discussion**

In this study, we directly compared two groups of young children, one with DD and one without, on a standardized measure of repetitive behavior. Stereotyped behavior was reported more frequently by parents of children with DD than by parents of a group of children without developmental delay (85.7% vs. 42.8%). The measure also provided information regarding the severity of stereotyped behavior (Bodfish et al., 2000). In that regard, the stereotyped behavior of children with DD was reported to be more severe than that exhibited by the children without DD. Surprisingly, over half of the children with DD (53%) were described as having at least one STY that was considered a moderate or severe problem in comparison with only 2% of the children without developmental delay.

More importantly, this study provides the first direct comparison of SIB in young children with or without developmental delay. SIB was more prevalent among the DD group than the TD group (59.1% vs. 28.5%) and was reported to be more severe as well. Specifically, the SIB of 30% of the children with DD received ratings of moderate or severe while none of the children in the TD group received such ratings. These findings provide support for the view that STY and SIB occur during early childhood, regardless of

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**Table III.** Repetitive Behavior Scale-Revised Stereotyped Behavior (STY) and Self-Injurious Behavior (SIB) Subscale Means and Standard Deviations (SD) by Chronological Age-Group and Developmental Delay Status

<table>
<thead>
<tr>
<th>Scale</th>
<th>Age-group (months)</th>
<th>DD (SD)</th>
<th>TD (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STY</td>
<td>0–24</td>
<td>4.80 (3.30)</td>
<td>1.60 (1.70)</td>
</tr>
<tr>
<td></td>
<td>25–36</td>
<td>2.90 (2.40)</td>
<td>0.47 (0.83)</td>
</tr>
<tr>
<td></td>
<td>37–47</td>
<td>3.60 (2.60)</td>
<td>0.31 (0.48)*</td>
</tr>
<tr>
<td></td>
<td>48+</td>
<td>7.20 (4.50)</td>
<td>0.90 (1.50)**</td>
</tr>
<tr>
<td>SIB</td>
<td>0–24</td>
<td>2.70 (3.00)</td>
<td>0.64 (0.92)</td>
</tr>
<tr>
<td></td>
<td>25–36</td>
<td>1.60 (1.50)</td>
<td>0.47 (0.74)</td>
</tr>
<tr>
<td></td>
<td>37–47</td>
<td>2.90 (4.20)</td>
<td>0.23 (0.60)</td>
</tr>
<tr>
<td></td>
<td>48+</td>
<td>2.60 (4.40)</td>
<td>0.30 (0.67)</td>
</tr>
</tbody>
</table>

* Means differ $p < .05$ (Tukey HSD test).
** Means differ $p < .001$ (Tukey HSD test).
developmental status. However, questions remain regarding the reported differences in severity for both STY and SIB. Given the design of the RBS-R, severity is defined by the degree to which the behavior is perceived as a problem by the respondent. These ratings could be determined by a variety of factors (e.g., frequency of occurrence, how difficult the behavior is to interrupt, how much the behavior interferes with ongoing events, or the degree to which the behavior provokes a response from parents, caregivers, or teachers). Observational studies of young children with and without developmental delay would provide important data regarding the factors responsible for the reported differences in severity of STY and SIB.

In this study, there were no significant age or gender effects in SIB subscale mean scores between groups of children with or without DD. Within the sample of children with DD, age was moderately related to STY subscale scores with higher STY scores evident in older children with DD but not in the TD group. Similarly, STY subscale scores were correlated with expressive and receptive language for children with DD such that children with more advanced development, and most likely chronological age, had higher STY scores. These findings provide support for a hypothesis of delayed onset/maturation of repetitive motor movement in the context of a typical developmental course (i.e., the STY reported in the DD group will follow a similar trajectory to that of the TD group but manifests at a later age). Longitudinal studies of young children with and without developmental delay are needed to sort out this apparent difference with respect to age as well as the timing of onset, progression, and offset of specific topographies of STY and SIB.

Limitations to the current study include the use of parent report of SIB and STY rather than direct observation. Parents in the DD group were reporting on DD and STY as part of an intake process to be seen by a specialty clinic for children with disabilities, so there is a possibility that they may have been more sensitized to questions about aberrant behavior than might be seen in the general population of children with developmental disabilities. However, the use of parent report mirrors the approaches used in most previous work, and parents were referred to the clinic through typical screening mechanisms; none were referred specifically for treatment of SIB or STY. Both samples were nonrandom, and so may not be representative, limiting the generality of the findings. The response rate for the TD sample was around one-third of distributed survey packets, so there is the possibility of a response bias. It is also possible that some children from the TD group may have undiagnosed or unreported developmental delays; however, this would reduce the observed differences between the groups. In this study, participants were matched on “chronological age,” but hypotheses around the effects of developmental delays on the trajectories of SIB and STY should also be examined comparing children based on “developmental age.” Finally, the design was based on cross-sectional (not longitudinal) data limiting the degree to which any inferences could be made with respect to temporal relations between SIB and STY.

While these limitations may reduce the generalizability of the study findings to the overall pediatric population, the findings provide support for understanding SIB as a developmental phenomenon. From a public health perspective, it is still not clear that pediatric scientists and practitioners understand the relevant variables that could be used to inform prevention programs aimed at reducing SIB among pediatric risk groups before the behavior becomes a fixed aspect of their behavioral repertoire (Symons, Sperry, Dropik, & Bodfish, 2005). A developmental perspective could provide an important framework for doing so. Prospective longitudinal studies of SIB with populations at risk for developmental delay are rarely conducted; doing so, however, would permit the “add in” of proximal measures (e.g., parent responsiveness) that might help predict the emergence of SIB, sort out the relationship between SIB and STY, address questions regarding heterotypic continuity (a behavior that changes in form but serves the same function throughout developmental states, see Schulenberg, Maggs & O’Malley, 2003), and aids in prevention efforts.

In sum, further research efforts should focus on the emergence of SIB in children with developmental delays that are at risk for intellectual and developmental disability. The costs of leaving this problem unsolved are borne by not only the individual but also the family and society. Almost three decades ago, the National Institutes of Health estimated that costs associated with SIB among individuals with neurodevelopmental disorders exceeded $3 billion (U.S.). There is little reason to think the prevalence estimates have changed but, assuredly, the costs of care have. Presumably, if risk could be more precisely estimated, then prevention and treatment resources could be more effectively allocated. The general sense that children with more significant developmental delay, including language delay, will necessarily be the same children with later SIB does not always seem to be supported by the data. A distinction between “risk” and “prognostic” factor may be worth considering. It may be that severity of developmental impairments—long considered to be risk factors—may be better thought of as prognostic factors when studying samples of young children.
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References


