Typical Children’s Responsivity Patterns of the Tactile and Vestibular Systems

Tami Bar-Shalita, Sarina Goldstand, Jeri Hahn-Markowitz, Shula Parush

OBJECTIVES. The purposes of this study were to investigate the responsivity patterns of typical 3- and 4-year-old Israeli children to tactile or vestibular stimulation, or both, and to examine whether differences in these patterns exist between them with respect to age and gender.

METHOD. The study sample consisted of one hundred seventeen 3-year-old and one hundred forty-three 4-year-old healthy Israeli children (N = 260). Mothers of these children completed a comprehensive tactile and vestibular responsivity questionnaire.

RESULTS. The subjects’ tactile and vestibular responsivity scores were neither hyperresponsive nor hypo-responsive. In addition, neither age nor gender was found to significantly differentiate between respective participant groups for hypo- or hyperresponsive behaviors.

CONCLUSION. Typical Israeli children can be characterized by moderate responsivities to tactile and vestibular stimulation. Responsivity to tactile and vestibular input was similar for 3- and 4-year-olds, across genders.

Sensory modulation has been defined as the “capacity to regulate and organize the degree, intensity, and nature of responses to sensory input in a graded and adaptive manner” (Miller & Lane, 2000, p. 3). The ability to modulate sensory input is critical for the developing child’s quality of life, efficiency of interaction within his or her physical and human environment, and optimal performance and adaptation to daily life challenges (Kimball, 1993; Miller, Reisman, McIntosh, & Simon, 2001).

Sensory modulation dysfunction (SMD) is a diagnostic term that refers to individuals who demonstrate exaggerated or inappropriate responses to sensory input (Bundy & Murray, 2002; Dunn, 1997; Parham & Mailloux, 1996; Royeen & Lane, 1991). Behavioral patterns demonstrated by individuals with SMD include hyperresponsivity, also referred to as “sensory defensiveness,” hypore sponsivity or “sensory dormancy” (Knickerbocker, 1980; Royeen & Lane), as well as patterns of fluctuating responsivity (Lane, Miller, & Hanft, 2000; Miller et al., 2001). In addition, researchers with extensive clinical and theoretical experience in this area have suggested that poor modulation may also be manifested by behaviors such as distractibility, impulsiveness, increased activity level, disorganization, anxiety, and poor self-regulation (Ayres, 1972; Cohn, Miller, & Tickle-Degnen, 1999; Lane, 2002; Miller et al., 2001).

Clinically, hyperresponsive symptoms include tactile, auditory, olfactory or visual defensiveness, or both; gravitational insecurity; and aversive responses to movement (Ayres, 1979, 1983; Knickerbocker, 1980; Lane, 2002). Knickerbocker described children with “sensory defensiveness” as being overly active, hyperverbal, distractible, and disorganized. Wilbarger & Royeen (1987) claimed, based on their...
clinical observations, that sensory defensiveness may result in emotional or affective difficulties. In a state of “defensiveness,” or overarousal, a fight or flight response will occur in reaction to incoming sensory stimulation.

Hyporesponsivity or “sensory dormancy” in children is reflected in a low arousal level and, like sensory defensiveness, it is characterized by disorganized behavior (Knickerbocker, 1980; Kimball, 1993). Ayres and Tickle (1980) saw this phenomenon as a problem in sensory registration, a construct defined by Miller and Lane (2000) as a form of underresponding in which a person does not notice stimuli that are salient to most others. Dunn (1997) agreed that such behavior might be reflective of poor sensory registration. However, she also suggested that some children who seem not to attend to certain stimuli might in fact have low thresholds of sensory responsivity and attempt to prevent overarousal through avoidance behavior. She has suggested that more research needs to be performed to understand the significance of specific behavioral responses to sensory input.

To date, various neurophysiological mechanisms have been postulated in which poor limbic or reticular system processing have been considered as structures relevant to the understanding of imbalances in sensory processing (Ayres, 1979; Bundy & Murray, 2002; Fisher & Dunn, 1983; Lane, 2002; Royeen & Lane, 1991). Miller and colleagues (McIntosh, Miller, Shyu, & Hagerman, 1999; Miller et al., 1999; Schaaf, Miller, Seawell, & O’Keefe, 2003) have initiated an intensive series of studies using psychophysiological measurements to quantify and characterize unusual patterns of sensory responsivity in a variety of diagnostic groups in comparison to those of typical children and children with symptoms of SMD.

In parallel, researchers and clinicians have been investigating the complex and sometimes seemingly contradictory behavioral patterns ascribed to sensory responsivity and modulation across a variety of populations and age groups (Baranek, Foster, & Berkson, 1997a, 1997b; Brown, Tollefson, Dunn, Cromwell, & Filion, 2001; Case-Smith, Butcher, & Reed, 1998; Daniels & Dunn, 2000; Dunn & Bennett, 2002; Ermer & Dunn, 1998; Kientz & Dunn, 1997; Pohl, Dunn, & Brown, 2003). To review, hyper- and hyporesponsivity were once thought to represent a behavioral continuum, with a tendency to overrespond to sensory stimuli at one end and to underrespond at the other (Royeen & Lane, 1991). However, based on clinical information in which children were seen to fluctuate between hyper- and hyporesponsivity, Royeen and Lane hypothesized a more complex, circular relationship between these two types of behaviors. In their model, the shift between hyper- and hyporesponsivity doesn’t require moving from one end of the continuum to the other, but may occur when, for example, a child responding in a defensive manner to sensory input becomes overloaded. This sensory overload may then lead to a shut down of sensory processing and result in behaviors associated with hyporesponsivity.

Some theorists have proposed that the relationship between hyper- and hyporesponsivity is best conceptualized not as a continuum, but as part of a multidimensional phenomenon that represents the interaction between an individual’s neurological threshold and behavioral response tendencies (Dunn, 1997), or between internal factors (i.e., attention, emotion, and sensation) and external factors (i.e., culture, environment, relationships, and tasks) (Miller et al., 2001). In fact, various authors have speculated that children with sensory responsivity deficits will not always over- or underrespond to environmental sensations, but have difficulty in finding the appropriate “middle ground” in which they can interact adaptively with the environment with the appropriate levels of modulation. This may be reflected by the fact that these children’s behaviors are not consistent from day to day or even for the same input, which has led theorists to believe that both behaviors are part of a unified underlying sensory modulation dysfunction (Lane, 2002).

One direction taken by researchers in order to refine the SMD construct is by examining whether hypo- and hyperresponsive behavioral responses to sensory stimuli may coexist in the same individuals, and to what degree. In one of the few studies that examined this specific question, Lai, Parham, and Johnson-Ecker (1999) compared measures of tactile defensiveness and dormancy for both typical and atypical children. Their results indicated that although tactile defensiveness and dormancy are significantly related, the strength of the association was not enough to confirm that over- and underresponsivity to touch are symptoms of the same dysfunction. They suggested that further research be done to clarify this issue (Lai et al.).

However, because current conceptualizations have not yet been comprehensively researched there exists a need for further studies that can develop and validate these issues (Lane, 2002). The first steps towards this process require that data regarding sensory responsivity behavior patterns be collected for various sensory systems in typical individuals from a variety of ages and cultures.

Research efforts in the study of SMD have also been directed to the investigation of the typical developmental and gender related patterns of sensory responsivity. In addition to its theoretical implications, such information could prove vital from a clinical perspective, for use in the identification and intervention of children with difficulties in sensory modulation functioning.
Dunn (1994) examined responsivity patterns in girls and boys of 3 to 10 years of age. Her findings suggest that younger and older children in this age range responded similarly to different inputs in six different sensory categories. Moreover, she found only 4 of 99 tactile input items to which girls (3 to 10 years of age) responded differently than boys. In a later study, Dunn and Westman (1997) found tactile responsivity to be significantly different for age and gender among an American national sample of children. Unfortunately, the effect sizes of their findings were not great enough for the purpose of clinical applications. Parush, Gal, and Heimann (1994) performed a study that focused on the sensory responsivity patterns of younger children. They found that there are gender-related differences in tactile responsivity of typical children between the ages of 11/2-2-year-olds and 21/2-3-year-olds, and that 11/2-year-olds respond differently to tactile input than do 21/2-year-olds. Further, recent research on infants and toddlers indicated the existence of a developmental trend in for sensory responsivity within some of the sensory systems (Daniels & Dunn, 2000). Therefore, to insure the validity and reliability of clinical reasoning with respect to the evaluation and treatment of young children, in whom sensory functioning may not be completely developed, it is important to conduct a thorough investigation of these abilities within each distinct age group (Watling, Deitz, & White, 2001). This seems especially appropriate, since poor sensory modulatory abilities in young children may affect their social, cognitive, and sensory-motor development, rendering accurate and early identification and intervention of dysfunction crucial for their overall well-being (Dunn, 2001).

It is also important to note that although clinicians often refer to subcategories of disorders according to the various sensory systems involved (tactile, vestibular, visual and auditory defensiveness, or dormancy), some researchers believe that SMD may be a generalized disorder that affects modulation across a number of sensory systems (Kimball, 1993; McIntosh, et al., 1999; Stephens & Royeen, 1998). Indeed, Blanche and Schaaf (2001) suggested that for example, “proprioceptive seeking,” a behavioral pattern consisting of hyperactive and “aggressive” or unsafe behaviors that may stem from children’s search for increased input, may be one manifestation of a general sensory modulatory disorder. This suggestion is based on their observations that such behavior is often concomitant with modulation deficits in other sensory systems, primarily of the tactile and vestibular systems (Blanche & Schaaf, 2001). Clearly, more research is indicated to help clarify the nature of sensory modulation and the relation between SMD and behavioral functioning.

Our research involved a comprehensive investigation of the tactile and vestibular systems, in part, because aversive reactions to touch and movement have been observed by occupational therapists and discussed in the professional literature for the past 40 years (Ayres, 1964). Therefore, at this point, tool construction was limited to those sensory systems for which the greatest amount of clinical data has been compiled.

Deficient modulation of the tactile and vestibular systems are considered to underlie limitations in environmental functioning (Ayres, 1979). The tactile system is considered, together with the proprioceptive system, as playing a primary role in early development, serving as a foundation for subsequent social, emotional, and academic performance (Royeen & Lane, 1991; Stephens & Royeen, 1998). Since touch is integrally related to so many areas of function, disordered modulation of the tactile system is a pervasive problem that impacts all areas of occupation (Lane, 2002). The vestibular system plays a role in three major functions, along with the visual system and the proprioceptive system: subjective awareness of body position and movement in space; postural tone and equilibrium; and stabilization of the eyes in space during head movements (Fisher, 1991; Lane). Vestibular modulation deficits have ramifications that include diminished environmental exploration and gross motor activity, and myriad secondary emotional and social ramifications (Lane). Clearly, both tactile and vestibular system dysfunction are recognized as substantially impacting quality of life and the ability to participate in age-appropriate occupations.

Cross-cultural research has revealed the impact of environment on children’s development (Kaniel, 1990; West & King, 1985). Generally, most cultures have their own distinctive child-rearing practices, and varying attitudes and expectations with respect to acceptable behaviors (Chen, Downing, & Peckham-Hardin, 2002; Williams & Williams, 1987). This would seem to be relevant with respect to the types of responses generated by typical children within each culture toward sensory events in their environment, especially with respect to touch in which cultural differences have been reported (Field, 2001). Thus, in order to understand the sensory responsivity patterns of typical children of different cultures, it is necessary to perform research in which these behavior patterns are assessed.

Therefore, the current paper investigated behavioral indicators of hypo- and hyperresponsive tactile and vestibular reactivity in typical Israeli preschool children, in order to investigate the following questions. First, what differences exist between 3- and 4-year-olds for such behaviors, across genders? In addition, because typical children were the focus of this research, the question was asked how are their scores distributed on a questionnaire measuring sensory
responsivity? The third question investigated in the current research was what relationship exists between hyper- and hyporesponsivity behaviors within either the tactile or the vestibular systems or both? The final question investigated was, what relationship exists between hyperresponsive behaviors, or hyporesponsive behaviors, or both, across tactile and vestibular systems?

By expanding the knowledge base in sensory modulation functioning with respect to possible developmental and gender related trends, we hope to contribute to the ability of clinicians to provide best practice for young children. Further, by assessing the sensory response patterns of typical children from a different cultural context, a wider understanding can be gained of a child’s capacity to regulate and organize sensory input for efficient interaction within his or her environment.

Method

This study used a group comparison design to compare sensory responsivity patterns between 3- and 4-year-old typical preschoolers across genders. A convenience sample was used for the purpose of investigating the research questions.

Subjects

A power analysis (Dupont & Plummer, 1990) with a desired power of .80 (as per Cohen, 1988) at a significance level of .05 indicated a required number of 37 subjects per group. This estimated power was calculated from Parush et al.’s 1994 study, in which significant differences were found between 1$\frac{1}{2}$- and 2$\frac{1}{2}$-year-old children using the same questionnaire as in the current study. To assure that this study was adequately powered, and reduce the risk of Type II error, the number of children per study group was increased well beyond the number required. Subjects included 260 healthy Israeli children, 117 were 3 years to 3 years and 11 months of age (51 males and 66 females), and 143 were 4 years to 4 years and 11 months of age (70 males and 73 females). It was decided to investigate this age range because prior research has examined the sensory processing of infants (1–3 years of age) (Daniels & Dunn, 2000; Parush et al.), yet no other studies have focused their attention specifically on preschoolers.

Subjects were randomly selected from a pool of children registered at “Mother and Child Health Care Centers” and from the Ministry of Education registers, from northern, southern, and central Israel. Mothers completed the Anser System Questionnaire (Levine, 1982), which contains 45 items on health and development, including items regarding pregnancy, birth, health-related problems, and developmental milestones, in order to screen subjects for typical development. Inclusion criteria included age and normalcy of development. Criteria for exclusion included preeclampsia during pregnancy, premature birth and low birth weight, respiratory problems, and intensive care treatment following birth. Additional inclusion criteria stipulated that the subjects’ mothers be healthy, and speak and understand Hebrew.

Instrument

A questionnaire regarding children’s responsivity to tactile and vestibular stimulation was developed specifically for this study to enable an in-depth and comprehensive probing of responsivity patterns for the ages being investigated. Following content validity, 97 items were deemed appropriate for use with respect to the tactile and vestibular systems, and an initial discussion that preceded the qualitative evaluation procedure indicated that it would be impractical to expect mothers to complete a lengthier questionnaire. Thus, for the purposes of this study, it was decided to limit the scope of the questionnaire to these two sensory modalities alone.

The questions were worded in a neutral manner in order not to bias respondents in the direction of hypersensitivity or hyporesponsivity. The tactile section included 65 questions in eight categories: Human Touch; Inanimate Surroundings; Head and Face; Food; Deep Touch; Clothes; Hands; and Legs. The vestibular section of 32 questions covered four categories: Gravitational Insecurity; Aversive Reactions. As can be seen the tactile section is composed of more items than the vestibular section reflecting the fact that, in contrast to the vestibular system, the tactile system incorporates a variety of sensory receptors with a wide distribution throughout the body and processes several types of stimuli (e.g., light and deep touch, and temperature).

<table>
<thead>
<tr>
<th>Table 1. Sample Demographics</th>
<th>Ages of Children</th>
<th>3–3.11 Years</th>
<th>4–4.11 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 117)</td>
<td>(n = 143)</td>
<td></td>
</tr>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>43.6</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>56.4</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Residence:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>15.4</td>
<td>15.4</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>84.6</td>
<td>84.6</td>
<td></td>
</tr>
<tr>
<td>Mothers’ education:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>59</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>41</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

*Note. No significant differences were found between study groups for any of the demographic variables.*
On the questionnaire each sensory section was further divided into a hyperresponsivity subsection and a hypo-responsivity subsection. Of the 97 questions, 10 in the tactile section and 19 in the vestibular section relate to hypo-responsivity; the remaining 69 questions relate to hyperresponsivity.

Each question is scaled on a 5-point Likert scale, with 5 representing the upper extreme of hyperresponsivity or hyporesponsivity, and 1 representing the lower extreme. For each question, the respondent is asked to choose one response out of a possible five that best describes their child's behavior most of the time. Items that are answered “Do not know” are rated 0. Total scores are obtained by adding the values of the ratings, and dividing by the number of items being answered. Items rated 0 were not included in the total score or considered as a question answered in the summation of the total scores. Four scores were obtained for each respondent: tactile hyperresponsive behaviors, vestibular hyperresponsive behaviors, tactile hyporesponsive behaviors, and vestibular hyporesponsive behaviors. Table 2 presents examples of questionnaire items and how they are scored.

Content validity for the questionnaire was conducted by 12 expert pediatric occupational therapists, according to a Table of Specifications (Benson & Clark, 1982). Items that were agreed upon by at least 75% of the therapists as belonging to the same category of the questionnaire were retained. A qualitative evaluation procedure with five mother participants followed. Items judged unclear were reworded.

Construct validity was demonstrated in that significant differences were found between a group of 32 typical children and 24 children with sensory modulation dysfunction, with respect to tactile hypersensitivity ($F = 7.94$, $p = .0007$), tactile and vestibular hypersensitivity ($F = 7.69$, $p = .0008$), and vestibular hyposensitivity ($F = 6.02$, $p = .0035$) (Bartov, 1997).

A test–retest reliability procedure was performed with 16 mothers of typical 3- and 4-year-old subjects, with an interval of 45–60 days between testing. Pearson correlation coefficient was calculated, yielding $r = .89$, $p = .001$. Internal reliability was calculated by employing an internal consistency procedure. The Cronbach alpha obtained was .829.

**Procedure**

Consenting mothers were contacted by telephone to schedule home visits during which they could be interviewed and complete the questionnaire. Completing the questionnaire took approximately 45 minutes.

**Data Analysis**

Multivariate analysis of variance (MANOVA) procedures were conducted to compare the mean total scores for hyper-responsive and hyporesponsive behaviors within each sensory system, between age groups and gender.

A Kolmogorov-Smirnov Goodness of Fit was performed on scores obtained for hyporesponsive and hyper-responsive behaviors for both sensory systems together, to determine normalcy in sensory responsivity distribution. Pearson correlation coefficients were calculated to determine the relationship between hyper- and hyporesponsive behaviors within each sensory system separately. These analyses were also performed to examine if a relationship exists between hyperresponsive behaviors, as well as between hyporesponsive behaviors, across the tactile and vestibular sensory systems.

**Results**

No significant differences were found in demographic variables (such as children’s gender, place of residence, and number of years of mothers’ education) between the two

### Table 2. Sample Questionnaire Items and Scoring System

<table>
<thead>
<tr>
<th>Hyporesponsivity Items</th>
<th>Likes very much</th>
<th>Likes</th>
<th>Neutral</th>
<th>Does not like</th>
<th>Greatly dislikes</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your child’s response when he or she touches hot objects (i.e., a hot dish)?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>What is your child’s response to jumping from extreme heights?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>What is your child’s response to tasting hot food?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>What is your child’s response to extreme spinning on the merry-go-round?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>What is your child’s response to falling down?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hyperresponsivity Items</th>
<th>Likes very much</th>
<th>Likes</th>
<th>Neutral</th>
<th>Does not like</th>
<th>Greatly dislikes</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your child’s response to having his or her nails clipped?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>What is your child’s response when you hug him or her?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>What is your child’s response to finger painting?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>What is your child’s response to climbing on playground equipment?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>What is your child’s response to performing somersaults?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

A test–retest reliability procedure was performed with 16 mothers of typical 3- and 4-year-old subjects, with an interval of 45–60 days between testing. Pearson correlation coefficient was calculated, yielding $r = .89$, $p = .001$. Internal reliability was calculated by employing an internal consistency procedure. The Cronbach alpha obtained was .829.
age groups (see Table 1). This lack of difference between groups was also found with respect to their responses regarding the 45 health and developmental variables included in the Anser System Questionnaire (Levine, 1982).

The mean total scores on the questionnaire for hyperresponsivity and hyporesponsivity for each sensory system, for each age group, and for the whole group are presented in Table 3.

MANOVA was used to compare the mean total scores for hyperresponsive and hyporesponsive behaviors for each sensory system, between age groups and gender (two by two table). Results did not reveal any significant effect for gender or age, either for hyperresponsive or hyporesponsive scores, within each sensory system. Neither was a significant interaction found between these independent variables \((F = .99; \ p = .729)\), which demonstrates that in each age group, the hyperresponsive and hyporesponsive behaviors of boys was similar to that of girls. In light of the fact that neither age nor gender differences were found, the scores for the two age groups were joined together.

A Kolmogorov-Smirnov Goodness of Fit was calculated for the items pertaining to hyporesponsivity and hyperresponsivity for both sensory systems together, to determine normalcy in sensory responsivity distribution. The \(p\) value was not found to be significant for either, indicating that the scores were normally distributed.

Seventy percent of the participants were clustered within one standard deviation of the mean for hyperresponsive behavior and 67% of the participants were clustered within one standard deviation of the mean for hyporesponsive behavior of both sensory systems.

In order to investigate the relationship between hyperand hyporesponsive behaviors, a Pearson correlation coefficient was calculated between the hyporesponsive and hyperresponsive scores, within each sensory system separately. Low significant correlations were revealed \((r = .14, \ p = .02\) for the tactile system, and \(r = .23, \ p = .000\) for the vestibular system).

Finally, Pearson correlational analyses were also performed to examine if a relationship exists between hyperresponsive behaviors in one sensory system to those types of behaviors (i.e., hyperresponsive) in the other sensory system, and if hyporesponsive behaviors of the two sensory systems are related. The results indicated that a significant moderate correlation \((r = .35, \ p = .000, \text{ and } r = .51, \ p = .000, \text{ respectively})\) exists between the same types of behaviors.

### Discussion

The comparison of the demographic variables of the two age groups demonstrated that they were well matched in 17 out of 18 variables. In addition, the subjects comprised a representative sample of healthy children with typical development, since they met all the health-related criteria for this study.

The results of this study indicated that no developmental differences exist between children 3 and 4 years of age with respect to parental report of their responsivity to vestibular and tactile stimulation. These findings, along with other research previously performed on various age groups of children, seem to confirm that a developmental trend may exist with regard to sensory processing in various systems that seem to asymptote by age 3. Daniels and Dunn’s (2000) research revealed that different patterns exist with regards to the tactile system in comparing infants 0–6 months old to toddlers 1–3 years old. In addition, research performed by Parush et al. (1994) comparing 1 1/2-year-olds and 2 1/2-year-olds, has also indicated that differences exist in tactile responsivity patterns, suggesting that gradual maturation of tactile responsivity still occurs in this age range (Gottlieb, 1976, 1983; Montagu, 1986). In contrast, Dunn’s (1994) findings indicated that such developmental trends do not distinguish between typically developing younger children (3-6-year-olds), and older children (6-10-year-olds), in that their responses to tactile and vestibular stimulation were found to be similar. Thus, the findings of this study, in which we focused on preschool children between 3 to 5 years of age, strengthens the contention that they, in contrast to younger children below 3 years of age, do not demonstrate significant differences, as

### Table 3. Means and Standard Deviations of Hyper- Hyporesponsivity Scores

<table>
<thead>
<tr>
<th></th>
<th>3–4 Years</th>
<th></th>
<th>4–5 Years</th>
<th></th>
<th>Total Sample</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Tactile hyporesponsi</td>
<td>1.81</td>
<td>.45</td>
<td>1.78</td>
<td>.52</td>
<td>1.79</td>
<td>.49</td>
</tr>
<tr>
<td>Tactile hyporespons</td>
<td>1.79</td>
<td>.40</td>
<td>1.76</td>
<td>.37</td>
<td>1.78</td>
<td>.39</td>
</tr>
<tr>
<td>Tactile hyporespons</td>
<td>2.50</td>
<td>.25</td>
<td>2.53</td>
<td>.22</td>
<td>2.52</td>
<td>.24</td>
</tr>
<tr>
<td>Tactile hyporespons</td>
<td>1.81</td>
<td>.39</td>
<td>1.78</td>
<td>.40</td>
<td>1.79</td>
<td>.39</td>
</tr>
</tbody>
</table>

Note: 3-4-year-old group, \(n = 117\); 4-5-year-old group, \(n = 143\).
reported by parents in their responses to tactile and vestibular input.

These findings, beyond their relevance in terms of theoretical aspects of the development of sensory responsivity patterns among typical preschool children, add to the ability of practitioners to provide for the early identification and treatment of sensory processing deficits. This is especially important for this age group, since many preschool activities revolve around the sensory exploration of objects and materials for learning. Further, early identification and treatment could potentially prevent the development of secondary problems associated with social-emotional and perceptual-motor development (Yochman, Parush, & Ornay, 2004).

In addition, this study did not reveal gender differences, which suggests that boys and girls between 3 to 5 years of age respond similarly to vestibular and tactile stimulation according to the reports provided by their mothers. These results, which suggest no age and gender differences, support the results obtained by Dunn (1994) who did not find meaningful gender and age differences.

Another purpose of this study was to investigate the responsivity patterns of typical children to tactile and vestibular input. The results of Kolmogorov-Smirnov Goodness of Fit suggest that the majority of the subjects’ tactile and vestibular responsivity, as reported by parents, is neither hyperresponsive nor hyporesponsive. Such findings regarding the moderacy of responsivity behaviors among typical children to sensory input, are in accordance with Kimball (1993). Kimball claimed that typical responsivity to sensory stimulation is reflected by moderate arousal and strengthens the speculation that typical children do not usually swing from hyper- to hyporesponsivity with respect to both these systems (Cermak, 1988; Royeen & Lane, 1991).

The low correlations that were obtained for the typical children between the hypo- and hyperresponsive scores within each sensory system suggest that they do not vary together, and therefore, one would not be able to predict one type of behavior based on the presence of the other. It should be emphasized that these low correlations were consistent findings across both sensory systems. In contrast, the findings that hyper- and hyporesponsivity to sensory input are characteristic of children with SMD has been indicated in a number of studies (Dunn, 2001; Lai et al., 1999).

The findings of this study also revealed that significant moderate correlations exist between hypo- and hyperresponsivity behavioral patterns across the tactile and vestibular systems. This result may suggest that typically developing children exhibit consistent responsivity patterns between these two sensory modalities. This is in accordance with Dunn (2001), who stated that in general, the levels of sensory responsivity remain the same across sensory systems and patterns of sensory processing, and that “people use consistent sensory processing patterns across time” (p. 613).

The findings of this study add to the growing information base regarding responsivity patterns of typical children to sensory input across a variety of ages, populations, and cultures. However, it must be taken into consideration that the responsivity data for this study was based on subjective reports from parents and caretakers, and was thus potentially biased. It is also important to consider that, as parents are intimately familiar with their children’s behavior, they are also capable of providing a rich and detailed picture of their child’s responses to sensory events in daily life.

Another limitation with respect to the findings of this study is that they can only be applied toward children of ages similar to those who participated in the study (i.e., 3- and 4-year-olds), and only with respect to tactile and vestibular responsivity. Occupational therapists have a vested interest in learning about the responses of individuals to sensory experiences. A generally accepted belief is that such information provides therapists with an enhanced ability to understand the choices that people make that can either support or inhibit their ability to live a satisfactory life, and allow for the application of this understanding for the provision of best occupational therapy practices (Dunn, 2001). Further empirical validation of this belief is essential as a foundation to occupational therapy practice in this arena.▲

Acknowledgments

We thank the mothers who were willing to share with us their child’s sensory responsivity for data collection. We also thank the Occupational Therapy School 3rd-year students, Tammy Katchelnik, Aliza Matityhu, Hana Notea, Yael Segal, Michal Weiss, and Aderet Yikne, for their assistance with data collection.

Funding for this project was supported in part by the Levine Center for the Development of Child and Adolescence, Department of Psychology, Hebrew University of Jerusalem.

References


Miller, L. J., & Lane, S. J. (2000, March). Toward a consensus in...


