Parents’ Report of Sensory Responsiveness and Temperament in Preterm Infants

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Key Words: infant, newborn • pediatrics • sensorimotor development

Objectives. Although most infants born prematurely do not have major developmental problems, those with perinatal medical problems and lengthy stays in the neonatal intensive care unit are at risk for sensory modulation problems and developmental sequelae. This study compared sensory responsiveness in preterm and full-term infants and examined the relationship of sensory responsiveness to temperament and developmental function.

Method. Caregivers of infants with (n = 45) and without (n = 22) prematurity were asked to complete the Sensory Rating Scale. The preterm infants were also evaluated with the Bayley Scales of Infant Development, Second Edition (BSID-II).

Results. The preterm infants exhibited more frequent behaviors indicating tactile defensiveness and difficult temperament than did the full-term infants. When specific items were examined, the preterm infants displayed sensory-seeking behaviors and high activity levels. As measured by caregivers’ report, sensory responsiveness was significantly related to temperament. It was not related to BSID-II Mental and Psychomotor scale scores.

Conclusion. This study supports the findings of others that preterm infants have mild problems in sensory responsiveness and temperament. Correlational results do not support a definitive relationship between parents’ reports of their infants’ sensory responsiveness and developmental function.

Outcome studies of preterm infants have determined that those born with low birth weight or extreme prematurity or who incur perinatal medical problems can be at risk for developmental delays (Als et al., 1994; Sostek, 1992). Although researchers concur that prematurity is sometimes associated with developmental delays, the degree and type of developmental risks have not been defined conclusively (Als, 1997; Bartlett & Piper, 1993; Sweeney & Swanson, 1990).

Risk Factors Associated With Preterm Birth

Although preterm infants are often spared severe disabilities, they do show a higher than average incidence of specific learning disabilities, lower IQs, attention deficit hyperactivity disorders, visuomotor impairments, spatial processing disturbances, language and speech problems, and school performance limitations (Als, 1997; Buehler, Als, Duffy, McAnulty, & Liederman, 1995). Als (1997) believed that “development in the extrauterine environment leads to different and potentially maladaptive developmental trajectories” (p. 48).

Studies of motor development in preterm infants have demonstrated conflicting results (Forslund & Bjerre, 1985;
Palisano, Ungerer & Sigman, 1983). On the basis of adjusted ages, motor milestones were equivalent (Palisano, 1986) or delayed (Ross, 1985; Ungerer & Sigman, 1983) when compared with full-term infants. In particular, preterm infants appeared to have poor quality of movement. Gorga, Stern, and Ross (1985) found that preterm infants had poor coordination compared with full-term infants. In their study of 80 infants, those who were preterm were more likely to be rated either hypotonic or hypertonic. Other differences in quality of movement include more tremors and more disorganized patterns (Cioni & Prechtl, 1990; Heriza, 1988). Bartlett and Piper (1993) reviewed outcome studies of preterm infants and found that they differed in muscle tone, qualitative aspects of movement, and gross motor milestones. Several researchers have reported that muscle tone was lower at term age but that tonal differences disappeared by 4 to 6 months (Forslund & Bjerré, 1985; Palmer, Dubowitz, Verghe, & Dubowitz, 1982). Drillien (1972) found increased muscle tone in about 50% of preterm infants who weighed 2500 g or less at birth. Of these infants, 60% showed resolution of the increased tone by 12 months of age. Other studies have confirmed that increased tone appears to be a transient problem (Gorga et al., 1985; Piper, Mazer, Silver, & Ramsay, 1988).

Sensory Processing in Preterm Infants
Sensory modulation refers to the ability of the central nervous system (CNS) to regulate how sensations are processed by the brain. Through sensory modulation, the CNS influences the perceived level of intensity of sensory input. The full-term infant can modulate his or her response to sensory input or regulate a balance between an inhibitory and excitatory response to sensory input (Royeen & Lane, 1991). Sensory modulation and processing are indirectly evaluated through the infant's responses to sensory input. An infant with a sensory modulation disorder demonstrates highly variable behaviors that seem to swing from dormancy (or underreactive responses) to hyperactivity (or overreactive responses) to sensory stimuli. Therefore, sensory modulation disorders are characterized by hyposensitivity or hypersensitivity (Dunn & Westman, 1997; Provost & Oetter, 1993). Problems in sensory modulation are thought to be experienced by preterm infants (Als, 1997; Als et al., 1986; Field, 1995); however, this notion has not been well researched. Als (1986) proposed that the sensory systems of the preterm infant continue to develop in the first months of life during which time the nervous system is immature, quite fragile, and vulnerable. The preterm infant copes with sensory input from the environment according to his or her level of neuromaturation (Als, 1992). The weeks after preterm birth and before 40 weeks gestational age are critical for neurological system maturation. In Als's theoretical model, the preterm infant's neurobehavioral organization is hierarchically organized, and lower levels must attain a certain degree of stability or equilibrium to support maturation of higher levels. At the lowest level, the very immature infant demonstrates only autonomic responses to sensory input. Heart and respiratory rate may fluctuate during different sensory experiences and may inhibit the infant's ability to make other responses to the environment. The ability to regulate behavioral state (i.e., degree of consciousness or arousal) appears to be related to the infant's ability to modulate and integrate incoming sensory information (Als et al., 1986; Als et al., 1994).

Two factors may create sensory responsiveness problems in preterm neonates, and these factors appear to interact (Als, 1986, 1992; Long, Lucey, & Philip, 1980; Vanden-Berg, 1995). First, compromised neurological and biological systems may limit sensory processing. Second, the neonatal intensive care unit (NICU) environment does not meet the sensory and developmental needs of an infant, whose most appropriate environment is the womb. A typical NICU has light and sound levels that are extremely high, constant, and mechanical in nature. This sensory input can potentially disrupt the development of sensory systems (DePaul & Chambers, 1995; Long et al., 1980). At the same time, the infant is deprived of the sensory input most natural at gestational ages less than term. The womb presents a dark, warm, supportive environment of rhythmic sounds and gentle vestibular input. Neonates with extreme prematurity or with critical medical conditions who stay in the NICU for prolonged periods are considerably deprived of their natural sensory environment and are overstimulated by the high technology required to support their lives. These infants have increased risk for negative developmental consequences (Long et al., 1980). They may learn maladaptive behaviors for coping or may incur neurological insults from physiological instability (Gorski, Hole, Leonard, & Martin, 1983).

When Wiener, Long, DeGangi, and Battaile (1996) compared the sensory processing of preterm and full-term infants, they found that their preterm sample scored lower than their typical sample in overall sensory responsiveness as measured by the Test of Sensory Function in Infants (TSFI) (DeGangi & Greenspan, 1989). At 13 months of age, the preterm sample scored in the deficit range on adaptive motor responses and reactivity to vestibular stimulation. They were at risk in ocular motor control and visual–tactile integration. Although preterm infants' scores were significantly lower than those of full-term infants, many preterm and full-term infants scored in the same range.

Sensory Responsiveness and Temperament
Sensory modulation disorders appear to relate to the infant's emotional development and social–interactive capabilities. Sensory modulation may be associated with limbic system function and the arousal system, with direct implications...
for behavior (DeGangi, 1991). Sensory modulation problems are also associated with difficult temperament (e.g., irritability, hyperactivity, distractibility) and problems in self-regulation. Regulatory disorders are officially defined as “difficulties in regulating behavior and physiological, sensory, attentional, motor or affective processes” (Zero to Three/National Center for Clinical Infant Programs [NCCIP], 1994, p. 31). Infants with regulatory disorders have difficulty with “sensory, sensory-motor, or organizational processing” (Zero to Three/NCCIP, 1994, p. 31). Overreactivity or underreactivity to each category of sensory input may characterize the infant (Zero to Three/NCCIP, 1994). DeGangi, Craft, and Castellan (1991) found in their clinical work that many infants with regulatory disorders also demonstrated sensory defensiveness, hyperactivity, and emotional and behavioral difficulties. Specifically, infants with regulatory disorders exhibited concurrent problems in regulation of emotions; irritability; poor self-calming; and hypersensitivity to auditory, tactile, visual, and vestibular stimulation.

In a 4-year follow-up of infants with regulatory disorders, DeGangi, Porges, Sickel, and Greenspan (1993) found that those who exhibited difficult temperament, characterized by emotional lability and behavioral difficulties, tended to also be hypersensitive to tactile and vestibular input. They often avoided touch, were irritable during dressing and bathing, and were intolerant of certain food textures (i.e., they were labeled as “picky eaters”). Furthermore, early hypersensitivity to sensory stimulation has been associated with later emotional difficulty. Using the TSFI, Wiener et al. (1996) found that infants with regulatory disorders registered “at risk” or “deficit” in sensory processing. Specifically, through 12 months of age, infants with regulatory disorders demonstrated some hypersensitivity to touch and poor performance in visual–tactile integration.

Sensory Processing and Developmental Function

A number of researchers have suggested a relationship between sensory responsiveness and developmental skill (DeGangi et al., 1991; DeGangi et al., 1993; Neisworth, Bagnato, & Salvio, 1995). DeGangi et al. (1993) hypothesized that both sensory defensiveness and difficult temperament have negative effects on cognitive processing. In particular, behaviors consistent with difficult temperament (e.g., poor attention, hyperactivity, irritability) may have a negative impact on cognitive function as the child grows older and the demands on cognitive processing increase. One basis for this association is the effect that these difficult behaviors have on the caregiver’s response. For example, when infants respond defensively to sensory input, caregivers tend to be more structured, less playful, and less physical (DeGangi et al., 1993). Less desirable, less positive, caregiver–infant interaction may result in delays in overall developmental function (Bee et al., 1982; Mahoney, Finger, & Powell, 1985).

Purpose

The purpose of this descriptive study was to compare sensory responsiveness of tactile, vestibular, auditory, and visual systems in preterm and full-term infants. A second purpose was to explore the relationships in preterm infants of sensory responsiveness to temperament and developmental function. Three research questions were posed:

1. On the basis of a parent’s report, do preterm infants born less than 36 weeks estimated gestational age and hospitalized in the NICU for more than 2 weeks demonstrate higher levels of sensitivity and more difficult temperament than full-term infants?
2. Is sensory responsiveness related to a parent’s report of infant’s temperament?
3. Is sensory responsiveness related to developmental function as measured by the Bayley Scales of Infant Development, Second Edition (BSID-II) (Bayley, 1993)?

Method

Sample

The sample included 45 preterm infants who spent at least 2 weeks (14 days) in the NICU at Children’s Hospital in Columbus, Ohio. Infants given specific diagnoses were excluded (e.g., cerebral palsy, Down syndrome, visual impairments, congenital anomalies). Criteria for inclusion were birth at or before an estimated gestational age of 36 weeks. The sample included 21 girls and 24 boys of whom 30 were Caucasian, 11 African-American, and 4 Asian. The characteristics of our sample were similar to those of other research on preterm infants, that is, they had developmental risk factors but no definitive condition specifically associated with functional problems (see Tables 1 and 2).

To compare sensory responsiveness, a convenience sample of 22 full-term infants, matched for age, was recruited through two large child-care centers. Each mother reported that her infant was full term at birth and did not have a major medical or developmental history. The mean age of the typical sample was 12.2 months (range = 10–15 months). Included were 12 girls and 10 boys of whom 16 were Caucasian, 2 African-American, and 4 Asian.

Instruments

Evaluation of sensory responsiveness. The Sensory Rating Scale (SRS) (Provost & Oetter, 1993), a written questionnaire for the primary caregiver specific to infants 9 to 36 months of age, was used to evaluate sensory responsiveness. The five subscales measuring responses to touch, movement, hearing, vision, and temperament were used in the present study. The items primarily measure sensory defensive behaviors (e.g., avoidance behaviors, sensitivity to...
stimuli). Examples of the temperament items include questions about the child's irritability, difficulty with changes in routines, poor sleeping, mood swings, aggressiveness, and activity level. Several items were deleted because they were inappropriate to infants at 12 months of age (e.g., prefers to wear sweatsuits). Using a Likert scale from 1 (never) to 5 (always), caregivers rate the frequency that their infants exhibit behaviors. Higher scores indicate greater frequency of sensory defensive behaviors; mean scores of 3 to 5 suggest sensory defensive behavior.

Provost and Oetter (1993) estimated reliability and validity of the SRS, using a sample of 117 full-term infants. Internal consistency, using Cronbach alpha procedures, was .90. Interresponder reliability was measured by correlating mothers' and fathers' responses. Percent agreement for scores within one point was 86%. Intrarater reliability within 1 week's time was .89 for the mothers and .95 for the fathers. The tool appears to have sufficient reliability and validity to be a useful measure of sensory responsiveness.

Evaluation of development. The BSID-II (Bayley, 1993) were used to measure mental and motor developmental levels in the preterm sample. Standardized scores based on ages that were adjusted for prematurity were used in the analyses. The test's author found that preterm infants demonstrated BSID-II Mental Developmental Index (MDI) and Psychomotor Developmental Index (PDI) scores that were slightly, but not significantly, below the norm for full-term infants. The MDI mean score for Bayley's preterm sample (n = 57) was 88.6 or .80 standard deviations below the norm; the PDI mean score was 83.5 or 1 standard deviation below the norm.

Procedure

The preterm infants were evaluated at the time of their 12-month follow-up visit at the Children's Hospital Neonatal Follow-Up Clinic. Although scheduled 12 months from the infants' birth, ages at the time of follow-up varied according to degree of prematurity (all ages were adjusted with the estimated gestational ages). Some infants were older than 12 months because of scheduling difficulties or health problems. When infants met the study's inclusion criteria, the caregiver or parent was asked to sign an informed consent form. Caregivers who consented to participate then completed the SRS during their clinic visit. The two occupational therapists who staffed the clinic administered the BSID-II, using standard procedures. The therapists were trained and had 3 or more years of experience in administering the BSID-II to preterm infants. Each infant's length of stay in the NICU, medical course, birth age, and birth weight were recorded from the medical file. Any significant medical history since the infant's neonatal hospitalization was also recorded.

For all infants in the sample except four, the mothers completed the SRS; for the remaining 4, grandmothers who were the infants' primary caregivers completed the form. The caregivers were asked to write in “NA” if they had never observed their infant in that situation (e.g., response to a haircut). One of the researchers was available while the caregivers completed the forms, although the instructions for the SRS seemed self-explanatory and few questions were asked.

Thirty SRS forms and brief demographic questionnaires about the infant's birth and development were sent to parents of full-term, healthy infants at two child-care centers. These forms were completed at home. The 22 completed forms returned to the researcher through the child-care center administrative staff constituted the typical sample.

Results

Sensory Modulation in the Preterm Sample

Statistical comparisons using independent t tests and Bonferroni correction to define an acceptable p value showed that the preterm infants were significantly higher than the full-term infants on the summary SRS scores, t = 3.38, p = .001, and sensitivity to touch, t = 3.54, p = .001. Caregivers of preterm infants also reported more frequent behaviors associated with difficult temperament, t = 2.48, p = .016; however, with the Bonferroni correction, this difference was not significant. See Table 3 for a visual comparison of all infants in the present study with the full-term infants of Provost and Oetter's (1993) study.

Table 1
Demographic Data for Preterm Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted age (months)</td>
<td>12.2</td>
<td>0.45</td>
<td>10–15</td>
</tr>
<tr>
<td>Gestational age at birth (weeks)</td>
<td>29.7</td>
<td>3.10</td>
<td>24–35</td>
</tr>
<tr>
<td>Birth weight (grams)</td>
<td>1435</td>
<td>652</td>
<td>630–3200</td>
</tr>
<tr>
<td>Number of days in the NICU</td>
<td>52</td>
<td>32.8</td>
<td>14–160</td>
</tr>
<tr>
<td>Number of medical problems at birth</td>
<td>5.45</td>
<td>2.0</td>
<td>2–9</td>
</tr>
</tbody>
</table>

Note: n = 45. NICU = neonatal intensive care unit.

Table 2
Perinatal Medical Problems of Preterm Sample

<table>
<thead>
<tr>
<th>System and Diagnosis</th>
<th>Frequency of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory</td>
<td></td>
</tr>
<tr>
<td>Respiratory distress syndrome</td>
<td>33</td>
</tr>
<tr>
<td>Bronchopulmonary dysplasia</td>
<td>17</td>
</tr>
<tr>
<td>Apnea</td>
<td>18</td>
</tr>
<tr>
<td>Neurological</td>
<td></td>
</tr>
<tr>
<td>Seizures</td>
<td>3</td>
</tr>
<tr>
<td>Perinatal asphyxia</td>
<td>5</td>
</tr>
<tr>
<td>Intraventricular hemorrhage grade III</td>
<td>2</td>
</tr>
<tr>
<td>Intraventricular hemorrhage grade IV</td>
<td>2</td>
</tr>
<tr>
<td>Periventricular leukomalacia</td>
<td>1</td>
</tr>
<tr>
<td>Cardiac</td>
<td></td>
</tr>
<tr>
<td>Patent ductus arteriosus</td>
<td>10</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
<tr>
<td>Metabolic</td>
<td></td>
</tr>
<tr>
<td>Hyperbilirubinemia</td>
<td>25</td>
</tr>
<tr>
<td>Anemia</td>
<td>6</td>
</tr>
<tr>
<td>Other (e.g., sepsis)</td>
<td>15</td>
</tr>
<tr>
<td>Retinopathy of prematurity</td>
<td>11</td>
</tr>
</tbody>
</table>

Note: n = 45.
Sensory Rating Scale Scores for Preterm and Typical Samples

<table>
<thead>
<tr>
<th>SRS Subscale</th>
<th>Preterm M (SD)</th>
<th>Typical M (SD)</th>
<th>Typical Sample M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Touch</td>
<td>2.22 (41)*</td>
<td>1.93 (25)</td>
<td>1.70 (74)</td>
</tr>
<tr>
<td>Movement</td>
<td>2.92 (56)</td>
<td>2.10 (43)</td>
<td>1.70 (68)</td>
</tr>
<tr>
<td>Hearing</td>
<td>2.19 (61)</td>
<td>1.99 (42)</td>
<td>1.65 (61)</td>
</tr>
<tr>
<td>Visions</td>
<td>1.64 (66)</td>
<td>1.70 (48)</td>
<td>1.50 (52)</td>
</tr>
<tr>
<td>Temperament</td>
<td>2.04 (65)</td>
<td>1.70 (39)</td>
<td>1.85 (70)</td>
</tr>
<tr>
<td>Total</td>
<td>2.18 (39)*</td>
<td>1.91 (23)</td>
<td>1.75 (67)</td>
</tr>
</tbody>
</table>

Note. SRS = Sensory Rating Scale.

*p = .05; mean adjusted age = 12.2 months. b = 22; mean adjusted age = 12.2 months. c = 117; mean adjusted age = 17.9 months.

*p < .001 (with Bonferroni's correction; p < .0083 needed to indicate significance).

We further examined differences between preterm and full-term infants by identifying the specific items that appeared relevant in the preterm infants. To be identified as clinically relevant, the item mean for the preterm sample had to be more than 2.5 and at least a half point greater than the mean for the typical sample. See Table 4 for behaviors that met these criteria.

Relationships Between Sensory Processing and Temperament

Using scores on the SRS, we correlated the preterm sample’s sensory responsiveness to touch, vision, movement, and auditory input with the overall rating of temperament (e.g., frequency of hyperactivity, irritability, sleeping difficulty, short attention span, aggressiveness). See Table 5 for Pearson correlation coefficients between sensory responsiveness and temperament.

Relationships Between Sensory Responsiveness Development and Behavior

Mean scores on the BSID-II indicate that the preterm infants scored within normal limits when adjusted ages were used (M = 100, SD = 15). The PDI mean score (89.90) was .67 standard deviations below the norm, and the MDI mean score (97.74) was at the norm (see Table 6).

Pearson correlation coefficients between BSID-II and summary SRS scores were extremely low and not significant; the coefficient between MDI and SRS was .022 and between PDI and SRS was -.079. The relationship between developmental function and temperament was of particular interest. This correlation was also very low (r = .001 for MDI and temperament, r = -.121 for PDI and temperament). When infants with low SRS scores (< 2.5, n = 33) were compared with infants with high SRS scores (> 2.5, n = 10) using an independent t-test, the groups did not differ on the BSID-II scales. The results suggest relative independence between the caregivers’ report of sensory responsiveness and the therapists’ evaluation of developmental function.

Discussion

Sensory Processing in Preterm Infants

Although the total SRS scores, as well as individual sub-scores for responsiveness to touch, were significantly higher for the preterm sample than for the typical sample, the mean SRS scores reflect minimal meaningful differences in behaviors. On average, caregivers of preterm infants indicated that their infants occasionally or sometimes exhibited sensory defensive behaviors. Parents of the full-term infants were less likely to indicate that their infants exhibited sensory defensive responses. To determine what sensory defensive behaviors were more frequently exhibited in the preterm sample, scores on individual items were compared.

Touch. For the 44 items used to rate tactile responsiveness, the caregivers reported 7 sensory defensive behaviors in the preterm infants (item means were 2.5 or higher and were at least .5 higher than those of the full-term infants). Taken together, the constellation of behaviors suggests a degree of hypersensitivity in the preterm sample. Wiener et al. (1996) found that at 12 months of age, preterm infants demonstrated tactile defensiveness as measured by the TSFI. Their research findings are similar to those found in this study in that the differences in tactile responsiveness, although significant, were not large and were of question-

Table 4 Sensory Rating Scale Items With Means 2.5 or Higher in the Preterm Sample and at Least .5 Higher Than in the Typical

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean for Typical Sample</th>
<th>Mean for Preterm Sample</th>
<th>% of Preterm Sample ≥ 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Touch</td>
<td>2.8</td>
<td>3.5</td>
<td>82</td>
</tr>
<tr>
<td>Arches back when held</td>
<td>2.0</td>
<td>2.7</td>
<td>49</td>
</tr>
<tr>
<td>Only likes to be cuddled by mom</td>
<td>2.5</td>
<td>3.2</td>
<td>71</td>
</tr>
<tr>
<td>Dislikes nails cut</td>
<td>2.1</td>
<td>2.7</td>
<td>61</td>
</tr>
<tr>
<td>Likes to be held only when chooses</td>
<td>2.0</td>
<td>2.8</td>
<td>49</td>
</tr>
<tr>
<td>Dislikes being with strangers</td>
<td>3.0</td>
<td>3.5</td>
<td>77</td>
</tr>
<tr>
<td>Needs to touch others</td>
<td>3.7</td>
<td>4.2</td>
<td>88</td>
</tr>
<tr>
<td>Bites objects</td>
<td>2.6</td>
<td>3.1</td>
<td>64</td>
</tr>
<tr>
<td>Movement</td>
<td>2.1</td>
<td>3.0</td>
<td>64</td>
</tr>
<tr>
<td>Likes to spin</td>
<td>2.1</td>
<td>2.6</td>
<td>54</td>
</tr>
<tr>
<td>Rocks while sitting</td>
<td>2.0</td>
<td>2.6</td>
<td>50</td>
</tr>
<tr>
<td>Auditory</td>
<td>1.8</td>
<td>3.0</td>
<td>72</td>
</tr>
<tr>
<td>Responds negatively to loud noises</td>
<td>2.0</td>
<td>2.6</td>
<td>50</td>
</tr>
<tr>
<td>Temperament</td>
<td>2.0</td>
<td>2.6</td>
<td>50</td>
</tr>
<tr>
<td>Seems more active than others</td>
<td>1.8</td>
<td>3.0</td>
<td>72</td>
</tr>
</tbody>
</table>
able clinical relevance. Scores of our preterm sample show that 33% have mean scores greater than 2.5 for the Touch subscale (i.e., the infants “sometimes” demonstrated behaviors consistent with tactile defensiveness).

Two behaviors that were observed frequently (“needs to touch others” and “bites objects”) suggest age-appropriate sensory-seeking behaviors. These sensory-seeking behaviors are often present in children without disabilities, and although they appeared more frequently in our preterm sample (more than three quarters of the sample frequently displayed), they do not suggest dysfunction. Dunn and Brown (1997) explained that these behaviors can reflect the natural drive of the child to seek sensory input. Early in life, sensory-seeking behaviors are consistent with a drive to integrate sensory systems (Ayres, 1979). Frequent sensory-seeking behaviors that appear extreme and suggest a lack of sensory awareness may help the child receive important information about the environment, thereby promoting perceptual learning.

One behavior reported frequently in the preterm infants (“arching back when held”) may reflect a motor rather than sensory issue. A pattern of hyperextension and shoulder retraction in preterm infants has been reported in a number of studies (Georgieff, Bernbaum, Hoffman-Williamson, & Daft, 1986; Gorga, Stern, Ross, & Nagler, 1988). Bartlett and Piper (1993) reported that preterm infants tend to have muscle tone problems and exhibit qualitative differences in the degree of extensor tone. When evaluating preterm infants, therapists should keep in mind that momentary trunk hyperextension is a common behavior and is probably not indicative of underlying pathology.

Movement. Of the 15 items measuring response to movement, the preterm sample scored higher than the typical sample on two items: “likes to spin” and “rocks while sitting.” This finding (64% of the sample were rated 3 or higher) suggests that preterm infants seek and enjoy movement. Seeking movement is a behavior observed in full-term infants (Dunn, 1997; Dunn & Westman, 1997), although 64% of our preterm sample sometimes or often exhibited rocking while sitting compared with 2% of Dunn and Westman’s (1997) sample of children without disabilities 3 to 10 years of age.

Why might preterm infants seek these movement experiences that provide strong vestibular input? One possible explanation is that they receive less vestibular stimulation in the first months of life than do full-term infants who remain in the womb (Hunter, 1996; Korner & Thoman, 1972). A number of authors have suggested that replacing life in the womb with sedentary life in an isolette or crib is detrimental (Als, 1992; Hunter, 1996; Sweeney & Swan­son, 1990). Spinning and rocking are movements that young children often use to receive vestibular input. These behaviors are important for promoting integration of the vestibular system (Ayres, 1979). Therapists may recommend goal-directed activities that provide strong vestibular input as a method to facilitate the child’s transition from spinning and rocking to more purposeful activities. Such recommendations always need to be monitored to ensure that the vestibular input has an organizing and calming effect; negative autonomic responses are also possible.

Temperament. Researchers have suggested that prematurity is associated with hyperactivity and attention problems (Cohen, Parmelee, Sigman, & Beckwith, 1988; Ross, Lipper, & Auld, 1990). Our preterm sample was significantly higher in only 2 of the 21 temperament items than the typical sample, both indicating higher activity levels. Caregivers reported that their preterm infants were highly active (72% were ≥3 on “squirmed and moved a lot”), indicating sensory-seeking behaviors that are fairly typical. Dunn and Westman (1997), using parents’ reports, found that 40% of children without disabilities are “always on the go” at least some of the time. Parents of preterm infants with high activity levels may benefit from suggestions for channeling high activity levels into socially appropriate and purposeful behaviors. Consultation regarding best methods for calming and organizing, using specific sensory input, may also be helpful.

In summary, although the preterm sample differed from the typical sample in sensory responsiveness, examination of the items reported to be observed most frequently did not strongly suggest sensory defensiveness. Multiple explanations are possible for each item, including that certain behaviors associated with tactile defensiveness may actually result from the transient dystonia or low tone known to characterize preterm infants (Drillien, 1972; Piper et al., 1988). Seeking vestibular input through rocking and spinning may indicate the infant’s need to integrate

### Table 5

Pearson Correlation Coefficients Between Sensory Responsiveness and Temperament Using the Sensory Rating Scale

<table>
<thead>
<tr>
<th>Sensory Category</th>
<th>Difficult Temperament</th>
</tr>
</thead>
<tbody>
<tr>
<td>Touch</td>
<td>.625**</td>
</tr>
<tr>
<td>Movement</td>
<td>.308</td>
</tr>
<tr>
<td>Hearing</td>
<td>.406**</td>
</tr>
<tr>
<td>Vision</td>
<td>.311*</td>
</tr>
</tbody>
</table>

*Note. n = 45. *p < .01. **p < .05.

### Table 6

Means and Standard Deviations for BSID-II Mental and Psychomotor Scales for the Preterm Sample

<table>
<thead>
<tr>
<th>Scale</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental Developmental Index</td>
<td>97.74</td>
<td>15.5</td>
<td>50–134</td>
</tr>
<tr>
<td>Psychomotor Developmental Index</td>
<td>89.90</td>
<td>20.8</td>
<td>50–130</td>
</tr>
</tbody>
</table>

*Note. n = 45. BSID-II = Bayley Scales of Infant Development—Second Edition. The mean for the BSID-II is 100, with SD = 15.*
and organize the sensory systems (Parham & Mailloux, 1996). Differences in temperament primarily reflect differences in activity level more than other dimensions of temperament (e.g., aggressiveness, irritability).

Correlation Between Sensory Processing and Temperament

Sensory modulation problems are associated with temperament in children with regulatory disorders. DeGangi et al. (1991) found that in infants with regulatory disorder, fussiness, irritability, distractibility, and poor attention presented concurrently with hypersensitivity to tactile, visual, and vestibular stimulation. A higher incidence of vestibular-based sensory integrative deficits, tactile defensiveness, motor planning, and hyperactivity were present in 4-year-old children with regulatory disorders (DeGangi et al., 1993). In our preterm sample, tactile, visual, and auditory defensiveness were significantly related to hyperactive and irritable temperament. The correlations between touch and temperament were highest; the relationship to touch accounted for about 40% of the variance in temperament. The pervasive nature of the tactile system may explain the strength of this relationship. Tactile defensiveness has often been associated with irritability and high activity level (Ayres, 1979; DeGangi & Greenspan, 1988; Larson, 1982).

The preterm infants in our study were not diagnosed as having regulatory disorders, and extremes of difficult temperament were not evident. The relationship between sensory defensiveness and temperament might have been stronger had infants with regulatory disorders been included in our sample. Our results show the relationships that have been documented in infants with regulatory disorders emerging in a preterm infant sample. In Dunn’s factor analytic studies (Dunn, 1994; Dunn & Westman, 1997), the relationships between sensory systems and behaviors indicative of difficult temperament are expressed in children without disabilities, but to a lesser degree than in children with sensory defensiveness and diagnoses such as autism (Kientz & Dunn, 1997).

Relationship Between Sensory Processing and Developmental Skill

In the first year of life, motor development appears to be more affected by prematurity birth than other performance areas. In a number of studies, 12-month-old preterm infants scored lower on the BSID PDI than on the MDI (Barrera, Rosenbaum, & Cunningham, 1986; Ross, 1985; Ungerer & Sigman, 1983). Gesell and Amatruda (1947) also found that preterm infants show delays in gross motor skills more often than in fine motor, adaptive, or language skills. Motor performance for our preterm sample was within normal limits.

In our study, the infants’ sensory responsiveness was not significantly related to the BSID-II MDI or PDI. Wiener et al. (1996) also found that cognitive function and motor function as measured by the BSID-II did not correlate with sensory processing in preterm infants. Only one sensory processing variable (visual–tactile integration) significantly correlated with motor development, $r = .374, p < .05$. Our results indicating low correlation are tentative, as our preterm sample did not demonstrate extreme sensory-processing problems. Research suggests that high levels of sensory defensiveness in infants with regulatory disorders are associated with delays in development (DeGangi et al., 1993).

Limitations

Because of the small sample size, results should be interpreted with caution. Sample size and use of a single NICU for recruiting participants limit generalization. Additionally, the SRS has evidence of reliability and validity but has not been extensively researched (Provost & Oetter, 1993). Dunn (1994) and Dunn and Westman (1997) have questioned the validity of some traditional measures of sensory defensiveness and found that certain behaviors listed on scales of sensory defensiveness are typical of all children. The validity of the SRS requires further research.

Two different methods were used to collect data using the SRS; for the typical sample, it was completed at home, and for the preterm sample it was completed in the clinic. Socioeconomic status was not measured but has a known influence on infant behavior and parent perceptions (Bryant & Ramey, 1987; Campbell & Ramey, 1994). Future studies should account for these variables.

Conclusion

Our sample of preterm infants, although without significant neurodevelopmental conditions, had spent a mean stay of 52 days in the NICU. Our results indicate that compared with a sample of full-term infants, our sample of preterm infants exhibited certain behaviors associated with tactile defensiveness and hyperactive temperament. Occupational therapists should know the possible problems in sensory responsiveness when providing services to preterm infants. Preterm infants who exhibited more frequent sensory defensive behaviors also exhibited more behaviors indicating difficult temperament, particularly high activity level. Frequency of sensory defensive behaviors did not relate to motor or mental developmental levels.

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