Comparison of Tactile Preferences in Children With and Without Cerebral Palsy

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Key Words: child development disorders • hand dysfunction, assessment • touch

Fifteen normal preschool children and 15 preschool children with cerebral palsy were presented with 10 pairs of objects and asked to identify their preference for one of the objects in each of the pairs. Five objects of different textures were used. The children only handled the objects, they did not view them during testing. The children with cerebral palsy chose hard objects significantly more often than they chose soft objects; the normal children had no significant choice preferences. Eleven of the children with cerebral palsy had choice patterns significantly different from those of the normal children. The apparent preference of the children with cerebral palsy for hard objects and their avoidance of soft objects suggests that they may have decreased tactile awareness and need the greater proprioceptive input that hard objects provide. The findings of this study indicate that preschool children with cerebral palsy may be at high risk for somatosensory disorders, which could markedly affect their hand function.

Tactile and proprioceptive sensations have long been recognized as affecting motor performance in general and hand function in particular. In the 1950s and 1960s, several articles (Jones, 1960; Kenney, 1963; Lyon, 1961; Monfraix, Tardieu, & Tardieu, 1961; Tachdjian & Minear, 1958; Tizard, Paine, & Crothers, 1954) addressed the topic of tactile dysfunction in persons with cerebral palsy. Since the early 1970s, however, only O'Malley & Griffith (1977) have addressed the identification of such deficits in children with cerebral palsy. The focus of evaluation and treatment has typically been placed on the more easily observable aspects of motor disability and on specific functional skill deficits rather than on underlying sensory problems. In contrast, a great deal of attention has been focused on the impact of sensory processing disorders (including those of the somatosensory system) on the adaptive responses of normal children and children with learning disabilities as well as on intervention for these problems with children who have sensory integrative deficits (Ayres, 1979; Clark, Mailloux, & Parham 1985). Similar information on the differences in tactile functioning between normal children and children with cerebral palsy is quite limited. This study of tactile preferences was designed to increase information in this area. For this study, tactile preferences were assumed to be indicators of the children's somatosensory perceptions.

Research conducted in the 1950s and 1960s suggests that the incidence of sensory deficits in children with cerebral palsy is high. Studies on children with spasticity found that at least 40% and up to 80% of these children showed sensory deficits, depending on the types of sensation tested, methods of testing, and age of children being tested (Tachdjian & Minear, 1958; Tizard et al., 1954; Twitchell, 1966). Children with spasticity were found to be much more likely to have sensory disturbances than those with athetosis (Tachdjian & Minear).

Monfraix et al. (1961) found that abnormal sensation may be present in both hands in a child with hemiplegia or in only one hand in a child with quadriplegia and that the side of the hemiplegia seems to be irrelevant with regard to the incidence of sensory disorders. Thus, comparing the child's two hands as a basis for determining whether a sensory deficit is or is not present may produce an inaccurate assessment of the child's functioning.

The most commonly identified types of sensory deficits in children with cerebral palsy include astereognosis, impaired 2-point discrimination, and difficulty with position sense (Jones, 1960; Kenney, 1963; Tachdjian & Minear, 1958; Tizard, Paine, & Crothers, 1954). O'Malley and Griffith (1977) used the Southern California Sensory Integration Tactile Perception subtests to assess sensory functions in 5- to 15-year-
old children with right or left hemiplegia. The results showed that 61.1%–83.3% of these children had abnormal findings in stereognosis, graphesthesia, and/or tactile localization. Jones identified problems in light touch and localization of touch in 75%–80% of children with cerebral palsy who were under 6 years of age.

Somatosensory disorders may be due to central nervous system deficits, such as those present in children with cerebral palsy. Lesions of the parietal lobe and/or the thalamus are often present when sensory discrimination in highly discriminative and spatially dependent functions is impaired or lost (Kenney, 1963; Tachdjian & Minear, 1958; Van Buskirk & Webster, 1955). More extensive central nervous system damage that affects subcortical areas, as well as cortical level functions, can cause all types of sensory information to be inadequately processed (Van Buskirk & Webster).

Children with cerebral palsy are also more likely to have sensory dysfunction associated with insufficient sensory experiences (Silver, Litchman, Simon, & Motmed, 1976; Tachdjian & Minear, 1958). Since many tactile and proprioceptive sensory experiences arise from active movement, a child with limited movement will have less sensory information than a child who can effectively move. Bobath (1971) believed that "we do not learn movements, but the sensations of movement" (p. 2). If the sensory information perceived is minimal or abnormal, movement is likely to be impaired.

Umansky (1973) studied the impact of restricted sensory information on movement in babies. His results suggest that young babies are particularly susceptible to ignoring a body part when sensory information to that body part is reduced. As a result of this decreased sensory input the baby may fail to integrate the body part into the body scheme. Lyon (1961) indicated that by 1 year of age the involved arm of a baby with hemiplegia is less functional than would be expected for the degree of motor disability caused by the hemiplegia. Perhaps sensory deficits, in addition to the motor deficits, contribute to the baby's limited arm use.

Several researchers (Bobath, 1971; Crosland, 1961; Green & Banks, 1962; Van Buskirk & Webster, 1955) described the impact that impaired sensation can have on hand function. They claimed that the functional use of the hand is impossible when sensory function is poor even in the presence of relatively good motor control, and that poor sensory function can be the cause of minimal hand use. Tachdjian and Minear (1958) found that hand function was no better than fair when a sensory deficit was present.

Few methods for identifying such somatosensory deficits in children with central nervous system dysfunction are available. The only standardized pediatric somatosensory tests that are in common use by therapists are the Kinesthesia and Tactile Perception subtests of the Southern California Sensory Integration Test battery (Ayres, 1980). Although they have been used in testing children with autism (Daniels, 1980), mild mental retardation (McCracken, 1975), cerebral palsy (O'Malley & Griffith, 1977), and meningomyelocele (Grimm, 1976), they were developed for use with children who have learning disabilities. The tests are appropriate for children aged 4·0–8·11 years, but test–retest reliability of individual tests in this battery is in the low-to-moderate range.

The feasibility of accurately assessing somatosensory functions in young children has been addressed by some researchers. Kenney (1963) and Tizard et al. (1954) have suggested that standard/typical sensory testing may not be reliable with children under 5 years of age. However, Tyler (1972) demonstrated that reliable responses could be obtained on stereognosis testing with normal 3-year-olds, but not with 2-year-olds. Jones (1960), though, demonstrated reliable testing of light touch and stereognosis in children 19 months to 3 years old. Both of these researchers did not require verbal naming of the objects used, but allowed nonverbal responses. Jones (1960) recommended testing in a manner that would not require the children to close their eyes.

One alternative to using these sensory testing methods with children is to assess their tactile preferences as an indicator of their somatosensory function. Danella (1973) investigated tactile preferences in 12 children with multiple disabilities and visual impairments, aged 3·7–8·2 years. Preference was assessed by simultaneously placing each child's hands on pairs of objects of similar size, shape, and color. The objects used were a yarn ball, a fur object, a brush, a wood block, a sandpaper-covered object, a sponge, a hot container, a cold container, and a vibrator. Thirty-six pairs, but not all possible combinations, were presented to each child. Preference was determined by timing the child's handling of the objects in each pair. The children most often showed a preference for the vibrator and least often for the fur and yarn. Danella suggested that the children may have avoided the objects that conveyed light touch because these objects elicited a protective tactile reaction from them. She noted that proprioceptive responses may be activated by the vibration and that this type of stimulus may help to inhibit aversive reactions to tactile stimuli.

Responsivity to somatosensory stimuli has been addressed by other researchers. Larsen (1982) asked mothers of developmentally delayed children questions designed to elicit information that might indicate the presence or absence of tactile defensiveness. Royeen (1986) is in the process of developing a touch...
A scale for school-age children. This scale taps tactile defensiveness by asking children to indicate their agreement or disagreement with questions about their responses to tactile stimuli. In contrast to these test/questionnaire methods, Ayres and Tickle (1980) assessed sensory responsiveness by providing stimuli to autistic children and observing their responses. Several types of stimuli were used, including tactile and proprioceptive stimuli. However, only the “joint traction” item (for proprioception) assessed the child’s responsiveness to sensory input specifically given to the arms and/or hands.

**Purpose of Study**

Most studies of sensory functioning in children with cerebral palsy seem to have been done with traditional sensory testing methods that have not been standardized on children and for which comparative norms do not exist. Those somatosensory tests that have been standardized generally have not been used to compare normal children with children who have cerebral palsy. Using the test results from a child’s less impaired upper extremity as a basis for determining whether or not the child has a sensory deficit in the more impaired upper extremity is not effective because the sensory deficit may be bilateral. The effects of a sensory deficit may have quite significant implications for a child because such a deficit may severely interfere with the child’s incorporation of the arm into the body scheme and ultimately into functional use. Studies of tactile preferences have been used with children but have tended to focus upon tactile defensiveness. Ayres and Tickle (1980), however, have considered the effects of both hypo- and hyperresponsivity to sensory stimuli and the impact of this on the treatment of children.

The purpose of this study was to determine if differences in tactile preferences exist between normal preschool children and preschool children with cerebral palsy. Tactile preferences were assumed to reflect somatosensory processing; thus, if different preferences were to be found, these would suggest differences in somatosensory processing. The hypothesis was that significant differences in preferences for textures would exist between the two groups of children.

**Method**

**Subjects**

The occupational therapist at a United Cerebral Palsy preschool program in the Baltimore area identified 52 of the 58 children in the program as meeting the study criteria. Children were eliminated from the study if they exhibited severe motor involvement, profound-to-moderate mental retardation, hyperactive behavior, and/or uncorrected visual or hearing impairments. The types of cerebral palsy represented in the group of 32 children were spastic quadriplegia, mixed quadriplegia, spastic diplegia, athetosis, left hemiplegia, right hemiplegia, and hypotonia. Stratified random sampling was used to select 50% of these children for the study \( (N = 16) \); thus, the various diagnostic categories had similar proportional representations in the sample.

All 16 children with cerebral palsy were identified as being in the mildly retarded to normal range of intelligence. One child with spastic quadriplegia did not participate in the study because of lack of parental consent. The remaining 15 children (8 boys and 7 girls) had a mean age of 4.27 years (see Table 1).

The sample of 15 normal 3- to 5-year-old children was selected from a group of preschool children attending the Towson State University Council Day Care program. Convenience sampling was used to identify approximately equal numbers of boys and girls within this age range from the program’s population. The mean age of this group of 7 boys and 8 girls was 4.44 years (see Table 1). None of these children were identified by their teachers as having any known disabilities.

**Equipment and Setting**

Five objects, all similar in size and shape but varied in texture, were used to assess the children’s preferences for objects. One object was constructed of each of the following materials: fur, foam, plastic brush bristles, sandpaper, and yarn. The fur and sandpaper objects were constructed by attaching the material to wooden dowels. The other objects consisted of only the actual materials—a piece of foam, the end of a hair brush, and a yarn ball. The brush bristles and sand-

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age (in years)</th>
<th>Type of Cerebral Palsy</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>4.1</td>
<td>Choreoathetosis</td>
</tr>
<tr>
<td>M</td>
<td>4.8</td>
<td>Left hemiplegia</td>
</tr>
<tr>
<td>F</td>
<td>5.7</td>
<td>Mixed quadriplegia</td>
</tr>
<tr>
<td>M</td>
<td>4.8</td>
<td>Spastic quadriplegia</td>
</tr>
<tr>
<td>M</td>
<td>5.3</td>
<td>Mixed quadriplegia</td>
</tr>
<tr>
<td>M</td>
<td>3.1</td>
<td>Spastic quadriplegia</td>
</tr>
<tr>
<td>F</td>
<td>3.0</td>
<td>Spastic diplegia</td>
</tr>
<tr>
<td>M</td>
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<tr>
<td>M</td>
<td>4.5</td>
<td>Spastic quadriplegia</td>
</tr>
<tr>
<td>F</td>
<td>3.8</td>
<td>Mixed quadriplegia</td>
</tr>
<tr>
<td>F</td>
<td>3.7</td>
<td>Hypotonia</td>
</tr>
<tr>
<td>M</td>
<td>5.7</td>
<td>Spastic quadriplegia</td>
</tr>
<tr>
<td>M</td>
<td>3.7</td>
<td>Spastic diplegia</td>
</tr>
<tr>
<td>M</td>
<td>4.2</td>
<td>Extrapyramidal (athetoid)</td>
</tr>
</tbody>
</table>

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paper objects were considered hard objects, and the other three objects were considered soft.

A 17 in. × 11 in. × ½ in. cardboard box was used as a means of concealing the objects from the subject's view during testing. The box was completely open in the back and had a 10½ in. × 5½ in. curtain-covered opening in the front. Objects were placed in the box from the back, and the subjects reached through the curtained opening. The bottom of the box was lined with a padded material to minimize noise created by object contact with the box.

Each subject was tested individually in a small room. The subjects with cerebral palsy were positioned appropriately in their adapted chairs or in a small wooden chair and wore a seat belt during the testing. The normal subjects either sat in a small chair or on an adult's lap so that they were able to easily reach into the box. All subjects sat facing the examiner. Distractions were minimized during testing.

Procedures

Each of the five objects was paired with every other object, resulting in ten pairs of objects. With this system, each object was presented twice to the left hand and twice to the right hand. All possible combinations of the five objects were not used because this would have resulted in too many pairs (and thus too long a test) for the subjects. The ten pairs were randomly ordered into fifteen different lists. Thus, each subject with cerebral palsy received the object pairings in a different order. The same 15 lists of presentation orders were used with the normal subjects. This system was used to ensure that order effects would be minimized.

Once a subject was seated for testing and the box was securely fastened to the desk or table in front of the subject, the procedures of the test were simply explained. The subject was told that this was a game. He or she was encouraged to reach through the curtain with both hands. The examiner placed the two objects approximately 5 in. apart and simultaneously placed one of the subject's hands on each object. Once the examiner's hands were removed, the subject was asked to feel the objects and pull out the preferred one. The activity required only the ability to partially open the hand and use a gross grasp pattern. Verbal encouragement was provided to sustain the subject's attention to and cooperation with the test. The data collection form was designed so that the hand used to select each object and the object choices were both recorded. Each choice was recorded before the next pair was presented. Interrater reliability was at 100% agreement.

Results

Chi-square analyses of the object selection patterns of the two groups of subjects were performed on all pairs of objects (see Table 3). The only significant differences in object choices at the \( p < .05 \) level were the pairings of fur/brush and sandpaper/foam. Two additional pairs, foam/yarn and yarn/brush, were at the \( p < .10 \) level.

Chi-square analysis was also performed for the total frequencies of object choices. The computed value of 17.532 was significant \( (p < .01, df = 4) \). Overall, the normal subjects showed more similar frequencies for each object than did the subjects with cerebral palsy (see Table 4).

Six of the 10 object pairings each had a hard and a soft object (i.e., brush with yarn). The number of times out of these six trials that each subject chose the hard object rather than the soft object was recorded. The maximum possible score was 6, indicating six hard object choices; the minimum score of zero indic...
Table 4
Object Choice Frequencies for Normal Children and Children With Cerebral Palsy

<table>
<thead>
<tr>
<th>Objects</th>
<th>Normal Children</th>
<th>Children With Cerebral Palsy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandpaper</td>
<td>25</td>
<td>43</td>
</tr>
<tr>
<td>Brush</td>
<td>30</td>
<td>39</td>
</tr>
<tr>
<td>Foam</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Fur</td>
<td>32</td>
<td>18</td>
</tr>
<tr>
<td>Yarn</td>
<td>36</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

cated no hard object choices (all choices were soft objects). The distribution of scores for each group of subjects is presented in Figure 1. A Mann-Whitney U test was computed; the obtained value of 161.5 was significant at the p = .01 level (nx = 15, ny = 15, two-tailed test p < .01, critical values of E Rx = 171-294) The normal subjects' mean was 2.667; the standard deviation was .869. The mean and standard deviation for the subjects with cerebral palsy were 4.467 and 1.784, respectively. Fourteen of the subjects with cerebral palsy scored within two standard deviations of the normal subjects' mean. Fourteen of the normal subjects scored within this range.

Sex differences and the effects of hand preference on object choice were also analyzed within and between the two subject groups by means of chi-square analyses. No significant sex differences were found with any object pairing. In seven of the ten pairings, normal subjects used their preferred hand for object selection slightly more often than their nonpreferred hand. Subjects with cerebral palsy used their preferred and nonpreferred hands approximately equally (on 50% of the pairs they more often used their preferred hands, and on 50% they more often used their nonpreferred hands).

When the responses were analyzed for the particular types of pairings on which the subjects used their preferred hands, those with cerebral palsy appeared to make choices based on the texture of the objects rather than on the side of presentation. Normal subjects showed no consistent pattern for category of objects selected with their preferred hands.

Discussion

Caution must be exercised in the interpretation of these data. First, both samples were small and may not be representative of the populations. Second, fine motor involvement could have influenced the children in making their choices. This motor involvement may have made grasping the softer objects more difficult; grasp may have been easier with the firmer objects. However, this would seem unlikely since the children were only expected to use a gross grasp on the objects. Manipulation of the objects, which is typical in many tactile tests, was not expected.

Another influence on the interpretation of the data is the fact that not all possible object pairings were used. For example, although fur/sandpaper was used, sandpaper/fur was not used. Because of these pairings, a child did not have the opportunity of having the sandpaper in the right hand and the fur in the left hand when making an object selection. Therefore, an interaction between hand and object could have occurred; thus, the analysis of specific object preferences overall versus object preferences in particular hands could have been affected.

However, the analyses that were performed indicated that hand preference did not have a significant effect on the choice of objects by the children with cerebral palsy. These children preferred the hard object even if it was in the nonpreferred hand. In addition, sex of the child also did not apparently influence object choice.

Significant differences in object preferences did emerge between the two groups of children. The normal children generally showed no significant preference for either hard or soft objects, or showed slightly more preference for soft objects. Almost all of the children with cerebral palsy seemed to prefer objects with a harder (firmer) texture. Given that 11 of the 15 children with cerebral palsy had scores on the number of hard choices (in pairs with both hard and soft objects) that were more than two standard deviations from the normal children's mean score, some difference in processing of tactile information or in tactile perception seems likely.

Children with cerebral palsy may have less exposure to objects and materials of different textures than normal children do. For example, many young children with cerebral palsy play outdoors less and, therefore, may have less contact with firm and rough ob-

![Figure 1](http://ajot.aota.org/)

Figure 1
Total Number of Hard Object Choices Given Hard/Soft-Soft/Hard Object Pairings for Both Groups of Children

Note: Children's scores are based on a total possible score of 6.
jects than normal children do. On the other hand, they may be more frequently exposed to soft, fuzzy toys, such as stuffed animals and foam handles on adapted utensils. Children are more likely to attend to unfamiliar objects than to familiar objects; thus, when presented with the sandpaper and hairbrush in this study, the children may have found these materials to be more novel and more interesting than the soft materials.

In regard to tactile perception differences, tactile defensiveness may be one explanation for children with cerebral palsy choosing the soft objects less often than the hard objects. The findings of this study are similar to those of Danella (1973): In both studies the least preferred objects were the yarn and the fur. Danella concluded that the children avoided the light touch of the yarn and the fur because these may have elicited the withdrawal response characteristic of the protective portion of the tactile system. Although this also could be a conclusion from this study, the children’s test behaviors would not seem to support it. They showed no specific evidence of tactile defensiveness during testing. In addition, both the hard and soft objects used in this study had properties considered to be adverse to children who have difficulty tolerating tactile contact.

Another explanation for the differences between the two groups is that the children with cerebral palsy have sensory disorders interfering with tactile perception. They may have more difficulty perceiving soft tactile contact and may therefore seek the firmer input provided by the hard objects. The harder objects would provide the children with more proprioceptive information than they would receive from the softer, lighter weight, less resistive materials. Thus, they may choose the object that provides them with more input.

Such disorders of tactile perception in young children with cerebral palsy would not be unexpected. The finding that 11 of the 15 children with cerebral palsy in this study had scores significantly different from the normal preschool children is in line with prior studies using more traditional methods of sensory testing.

It has been suggested that formal sensory testing with very young children is difficult; yet the method employed in this study seems feasible. Few problems with attention and/or cooperation were encountered in testing these 30 preschool children.

Implications

This study’s findings have implications for upper extremity–fine motor intervention with young disabled children, whether the cause of the deviation from normal is tactile defensiveness or a sensory perception disorder. Currently, intervention with these children typically focuses on improving their motor functioning and skill functioning. Although sensation is considered in treatment, few programs specifically focus on enhancing the child’s somatosensory awareness and use of somatosensory information. Given the results of Umansky’s (1973) and Lyon’s (1961) studies, which suggest that an early sensory deficit influences the integration of the limb into the body scheme and the later functional use of the extremity, it would seem important to provide sensory habilitation as well as motor habilitation for young children with cerebral palsy. Intervention to improve motor performance may be enhanced by simultaneous, specific emphasis on sensory functioning.

On the basis of this study’s findings, the following clinical strategies regarding adaptive equipment and toy choices may be considered. Children with cerebral palsy may have difficulty perceiving and managing soft handles on adapted tools. They may not feel the foam on a spoon handle as well as they would feel a hard handle made of wood or thermoplastic (and the latter may provide them with the information for more adequate grasp). At least some toys used with severely handicapped babies may need to be firm, nonsqueezable objects so that the baby has the opportunity to handle them and to acquire cognitive skills that accompany object manipulation. Firm objects could be used until the therapist has carefully assessed whether or not the baby perceives and responds appropriately to soft objects and, if necessary, has intervened to improve the baby’s perception of soft objects.

Recommendations

Considering the limitations of this study and the outcomes of the data analyses, several directions for further research are possible. First, the study could be replicated with the use of all possible pairs and their reciprocals so that the possible interaction of hand preference and object selection could be more completely assessed. In replicating the study with a larger sample of both normal children and children with cerebral palsy, the usefulness of the tool as a simple screening of somatosensory perception in young children may be determined. In addition, test–retest reliability also needs to be determined before this method could be used to assess somatosensory preference/perception in individual children. Finally, children’s histories regarding factors that may indicate the possible presence of tactile defensiveness could be correlated with the test results.

If this method were demonstrated to be a reliable and valid measure of general somatosensory perception in young children with disabilities, the effects of intervention designed to remediate any dysfunction...
in this area could be measured. Perhaps “sensory education” (similar to the sensory reeducation done with older individuals) is appropriate for this population of children. Such intervention might have a greater effect on the child’s overall hand function if it were provided at a very early age rather than when the child is old enough to respond accurately to more traditional sensory evaluations.

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