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Haptic Exploratory Strategies and Children Who Are Blind and Have Additional Disabilities

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Abstract: This study of the haptic exploratory strategies used by nine children with visual impairments and additional disabilities when interacting with portable and freely manipulable objects found that a broader approach to assessment and analysis is required than is used with typically developing children. An "adaptive-tasks" approach is proposed as a basis for developing a framework within which to account for sources of variance in the developing haptic abilities of these children.

Haptic perception can be described as perception that relates to the sense of touch, particularly to the ways in which it is possible to discriminate and recognize objects from handling them as opposed to looking at them (Bushnell & Boudreau, 1993). As McLinden and McCall (2002) noted, however, relatively little is known about the ways in which children who are visually impaired (that is, those who are blind or have low vision) and have other disabilities use touch when they engage with their environment, and given the wide range of the educational needs of these children, the role of haptic perception in a child's learning and development can be easily neglected.

The study described here was concerned with one particular area of haptic perception in relation to visually impaired children with additional disabilities, namely, the haptic exploratory strategies used when interacting with objects. Three broad research questions guided the focus of the investigation:

1. What is the nature of the haptic strategies used by children with visual impairments who have additional disabilities with respect to portable and freely manipulable objects (that is, objects that can be freely manipulated in either one or both hands)?

2. To what extent can haptic strategies that serve an apparent exploratory (that is, information-gathering) function be identified?

3. Which assessment approach may be the most appropriate for identifying and analyzing the observed haptic strategies?

A brief review of literature related to this study is presented next. A more detailed review of the wider literature in this area is reported in McLinden (1999), McLinden (2000), McLinden and Douglas (2000), and McLinden and McCall (2002).

Review of the literature

Early haptic perception

The literature provides evidence of a clear developmental progression in the haptic abilities of typically developing children that emerges in early infancy and continues to mature throughout childhood (Warren, 1982). In the early stages of this progression, the role of the oral system has been highlighted, and research has suggested that infants, up to at least 7 months of age, use oral exploration in particular ways for early exploratory activities (Ruff, 1984). With increased maturity of hand function, including a more developed haptic system, the hands adopt a greater exploratory function, increasingly in combination with the visual modality, which leads to the development of more sophisticated haptic strategies (Rochat, 1987). Indeed, developmental studies have supported the view that vision is an important "motivator that leads the hand into space and serves to facilitate grasp and manipulation" (Pehoski, 1995, p. 140).

The work of Piaget (for example, 1926, 1953, 1954) has been central in laying the foundations for current theories of early haptic development, particularly the importance of early exploratory activity and its role in cognitive development. A main tenet of Piaget's theory of intelligence (Piaget, 1953) is that representational thought evolves from overt activities with objects during infancy and that the emergence of particular motor abilities may determine some aspects of "perceptual and cognitive development, rather than the other way around" (Bushnell & Boudreau, 1993, p. 1006). Piaget outlined three broad periods of development: the sensorimotor, preoperational, and operational (concrete and formal) periods. Of particular relevance to this study is the early cognitive development that takes place during the sensorimotor period, which, in a typically developing child, covers the first two years of life and consists of six stages.

In contrast to Piaget's description of early haptic development is an influential model outlined by J. J. Gibson (1966), which postulates that action is *not* prior to perception, but that perceptual information is actively sought through "coordinated systems of action," a number of which are already functioning in this capacity at birth (Lochman, 1986, p. 25). In this model, J. J. Gibson introduced the notion of "perceptual systems," proposing that newborns are equipped with the capacity to learn about and differentiate objects in the perceived world through these systems, which are designed to process information about objects and the environment. J. J. Gibson (1979) introduced the concept of *affordance*, a term he used to describe a function that emphasized the "utility" of some aspect of the environment. He proposed that perceptual systems are used to extract information about the affordances of the environment; that learning about affordances entails "exploratory activities"; and that through such active exploration, an infant learns about the particular properties of objects (for example, texture, shape, weight, and substance).

E. J. Gibson (1988) reviewed the role of exploratory behavior in children's development of perceiving, acting, and acquiring knowledge and in relation to haptic perception, distinguishing between actions that are *executive* in nature (for example, reaching, grasping, and locomoting) and actions that are *information gathering* (that is, linked to the perceptual systems). She proposed that although the possibilities for executive actions are "minimal" in infants, *opportunities* for exploratory activities are available and are "used in functional ways even in the newborn" (p. 6). Furthermore, E. J. Gibson stressed the links between the role of executive actions in cognitive development, with particular consideration of the ways in which they change the affordances of things and places, thereby providing the child with new occasions for gathering information and acquiring knowledge. Therefore, she concluded, as new actions become possible, new affordances are brought about, and both the information that is available and the mechanisms for detecting them increase.

Classification of haptic strategies

A number of classification schemes have been outlined in the literature to describe the range of haptic movements that are used to manipulate and explore objects (see, for example, Appelle, 1991; Davidson, Abbot, & Gershenfield, 1974; Revesz, 1950; Zinchenko & Lomov, 1960). More recently, the work of two psychologists, Klatzky and Lederman, has been influential in making explicit the links between observed haptic strategies and the specific properties of objects (for example, surface temperature, texture, and hardness). As part of a series of experimental studies (for example, Klatzky & Lederman, 1993; Klatzky, Lederman, & Metzger, 1985; Klatzky, Lederman, & Reed, 1987; Lederman & Klatzky, 1987), these researchers investigated the perceptual abilities of the hands with adult explorers. They identified a link between hand-movement profiles and the perception of specific properties of objects and grouped the hand-movement profiles into distinct *exploratory procedures* (EPs). An EP is defined as "a stereotyped pattern of hand movement" that maximizes the sensory input corresponding to a certain property of an object and is considered to have "certain characteristics that are invariant and others that are highly typical" (Lederman & Klatzky, 1987, p. 344).

Lederman and Klatzky (1987) proposed that certain classes of hand movements could be directly related to distinct dimensions of desired knowledge about objects and that by identifying these classes and their relationships to the goals of acquiring knowledge, it would be possible to investigate the underlying haptic representation of objects in memory, as well as the processes by which these hand movements are created and used, suggesting that exploratory movements can serve as "windows through which the haptic system can viewed" (p. 344). The most salient properties of objects were found to be those for which relatively precise information was extracted using hand movements that were relatively fast and simple to execute. The properties of *texture* , *temperature,* and *hardness* , for example, were found to be prominent with "spontaneous" haptic perception. These properties required only brief repetitive hand movements that could be applied over a limited part of the object. A link between hand-movement profiles and the perception of specific object properties was identified, with the profiles grouped into six broad "exploratory procedures," or EPs: (1) *lateral motion* —rubbing the fingers across the surface of an object, (2) *pressure* —squeezing or poking an object, (3) *static contact* —holding the fingers static on the surface of an object, (4) *enclosure* —holding or grasping an object with the hand, (*5) unsupported holding* —holding an object unsupported in the hand, and (6) *contour following* —tracing along the contours of an object with the fingers.

Although useful as a broad framework for analyzing complex hand movements, the work of Klatzky and Lederman was concerned only with individuals who had well-developed haptic abilities and displayed a wide range of exploratory movements. Thus, the model has limited relevance for children with emerging haptic abilities and was revised by Bushnell and Boudreau (1997, p. 4) on the basis that "infants do not motorically execute the full range of movements encompassed by Klatzky and Lederman's EP's." Although full details of their model is outside the scope of this review, in essence, Bushnell and Boudreau (1997) proposed that to perceive the properties of objects with any precision, a developing infant must be able to perform a range of hand movements that are effective for apprehending these properties, such as rubbing a finger across the surface of an object to determine its texture. An infant from birth to 3 months may be able to obtain some haptic information (for example, surface temperature and possibly size) about an object by clutching it, but she or he would not yet be able to obtain accurate haptic information about the shape of the object, for example. It is only when the infant has developed more sophisticated exploratory strategies, such as using one hand to hold the object and one to explore it, at about age 12 months (described by Bushnell & Boudreau, 1997, as complementary bimanual activity, or CBA), that he or she may be able to determine the shape of an object.

Haptic perception and children who are visually impaired

Given the role of vision in early haptic development, it is not surprising to find evidence from developmental studies of infants who are visually impaired that have shown a delay in the use of the haptic system (see, for example, Fraiberg, 1977), although the evidence for such a delay is far from conclusive (see, for example, Warren, 1994). The ways in which children and young people who are visually impaired make use of touch for exploration and learning have been well documented, particularly in relation to reading through touch (Millar, 1997; Tobin, 1994; Warren, 1994), perceiving shapes tactilely (Millar, 1997), and using tactile diagrams (Kennedy, Gabias, & Nicholls, 1991). Much of this research, however, has been conducted with children and young people who have no additional disabilities. For children who have multiple disabilities, including visual impairments, relatively little is known about the ways in which they use their haptic abilities when engaging their environment, although there is an emerging body of literature in this area (Davidson, 1985; McLinden, 1999; McLinden & Douglas, 2000; McLinden & McCall, 2002; Nielsen, 1988; Rogow 1987).

A number of these studies (McLinden & Douglas, 2000; Nielsen, 1988; Rogow, 1987) have highlighted the importance of children's haptic abilities in early learning and development. Thus, Nielsen (1988) noted that the development of hand movements should be considered to be of decisive importance for the future ability of visually impaired children to be able to "see" and proposed that activities at all stages of development need to include opportunities for the development of such hand movements. Similarly, Rogow (1987) concluded that the failure to develop independent hand function severely impairs children's control over the environment and that a poorly developed grasp leads to distorted or only "vague" impressions of objects. The data as a whole suggest that manual function should be an important consideration in assessment and educational programs for children with severe visual impairments.

An individual case study of the haptic exploratory strategies of a congenitally blind child with multiple disabilities (McLinden & Douglas, 2000) reported that these strategies were characterized by a level of complexity and apparent uniqueness when compared with those of other children in the population. However, the results indicated that although the child demonstrated sophisticated haptic-manipulation behaviors with a range of experimental objects, these behaviors appeared to have a limited exploratory (that is, information-gathering) function. The case study was used as a pilot study to clarify a number of themes for research before a larger study of the haptic abilities of a range of children with visual impairments and additional disabilities was begun. This larger study forms the basis of this article.

Methods

Participants

The participants for the study were selected on the basis of the following criteria. First, they were chosen from children aged 1–16 who were registered as blind, had additional disabilities, and were assessed as functioning at "early" levels of cognitive development. In terms of educational attainment, this latter criterion referred to children who were functioning significantly below age-related expectations, as measured by performance criteria of the United Kingdom National Curriculum. Second, I had direct access to the children to observe them in the classroom and to undertake experimental work. Third, parental and school permission was granted for me to obtain information from the children's files and to videotape the experimental work undertaken with each child for coding purposes.

The heads of services, specialist nurseries, and head teachers of specialist schools for children with visual impairments in the Midlands region of England were contacted by telephone. I visited children who were identified as meeting the criteria and discussed the aims of the study with the relevant professionals and/or parents. The final sample for the study consisted of nine participants, with chronological ages ranging from 3 to 15 years, who attended a range of educational facilities: a specialist nursery for children with visual impairments (one participant), schools for students with severe learning difficulties (four participants), and specialist schools for students with visual impairments and additional disabilities (four participants). Table 1 presents the characteristics of the nine participants.

Selection of assessment procedures

Although a number of published tests have been designed to examine the accuracy of haptic identification in sighted children and infants (see, for example, Exner, 1992), no single procedure was identified in the literature that was appropriate for the identified focus. Therefore, I developed an assessment portfolio, consisting of a number of relevant procedures, for use in the study. The criteria for selection included the relevance of the scales both to the focus of the study and to the identified population. Selection was initially made from the list of procedures that were identified as being most commonly used with children with visual impairments and additional disabilities in the United Kingdom (Griffiths, 1991; McLinden, 1998). The procedures (or subscales therein) that were considered to have particular relevance to the focus of the study were the Sensorimotor Understanding subscale of the Reynell-Zinkin Scales (R-Z scales; Reynell & Zinkin, 1981), the Nielsen Functional and Instruction Checklist (Nielsen, 1990), and the Fine Motor and Cognitive subscales of the Callier-Azusa Scale (C-A scales; Stillman, 1978). Two additional procedures that I had used successfully to assess the haptic abilities of children with multiple disabilities, but that were not included in the list, were also included in the assessment portfolio: the Schemes subscale of the Ordinal Scales of Psychological Development (OSPD; Dunst, 1980) and the Object Related Scheme Assessment Procedure (ORSAP; Coupe & Levy, 1985).

Given the heterogeneity of the population of participants of this study, the research methodology was broadly based on an interpretive (or idiographic) paradigm (Cohen & Manion, 1994). In line with this approach, the research theory was considered to be largely emergent and was governed, to some extent, by the data generated during the research activity. The study adopted an exploratory approach (Herbert, 1990) by which data were collected using cross-sectional case studies (McKinney, 1994), drawing on descriptive observations in combination with quantitative data from the selected assessment procedures. The procedure used for collecting and analyzing data for each participant was based on a protocol that was developed and refined in the pilot study (McLinden & Douglas, 2000).

Procedures

Background information on each child was first gathered from the school files and supplemented, when appropriate, through interviews with relevant professionals (for example, the classroom teacher and the physiotherapist). Data on each child's haptic behavior repertoire (HBR) was then collected over a number of sessions during half a school term (approximately six weeks). At least two visits were made to each participant's school or nursery to observe and document the participant's haptic abilities during interaction with a range of portable and freely manipulable objects ("familiar" and "novel"). Each session lasted approximately 40 minutes and was structured to enable me to administer the procedures that were included in the assessment portfolio. Following each session, 5–10-minute video recordings were made of each child's haptic interactions with a number of objects in different contexts, such as break time, lunchtime, and physiotherapy. Any issues that were observed in these recordings were addressed in the interviews with appropriate staff members.

On the basis of the findings of the assessment, a preliminary analysis of the child's HBR was undertaken. This preliminary analysis was followed by further observation of the child's HBR. Between two and three further sessions for each child were planned over the course of the half term to observe the child's haptic behaviors in response to a wider range of haptic stimuli. A semistructured interview was conducted with each child's teacher to verify the observations and gain further insights into the observed haptic activity on the basis of the selected video sequences. When permission was granted, the interview was taped, and a transcript was made for future analysis.

Results

Assessment procedures

The participants' assessment scores on five scales from the assessment portfolio are summarized in Table 2, ranked according to chronological age. The results show that chronological age could not be used as a predictor of the level of cognitive function, as assessed by the OPSD and ORSAP, because two of the older children in the sample (Gary and Kevin) were assessed as functioning at Stage 1 or 2 of the sensorimotor period, and the youngest child (Jess) was assessed as functioning at Stage 4. The four participants who were assessed as functioning at Stage 4 of the sensorimotor period, as measured by the OSPD (Ricky, Aaron, Dave, and Jess) also attained the four highest scores on the Cognitive Development subscale of the C-A scales, indicating a high level of agreement at the upper end of the scales.

These four children also attained relatively high scores on the Fine Motor subscale of the C-A scales, indicating a broad correlation between the assessed level of fine-motor skills and the level of cognitive development. An exception to this finding was Nick, who attained a relatively high base-step score (8) on the Fine Motor subscale but a relatively low base-step score (2) on the Cognitive Development subscale of the C-A scale and a low score (Stage 3) on the OSPD. Similarly, Gary attained a relatively high base-step score (5) on the Fine Motor subscale but a relatively low base-step score (3) on the Cognitive Development subscale.

The degree of relationship between the procedures was measured using a Spearman rho correlation coefficient on the *ranks* of the assessment scores for each set of data (Snodgrass, 1977). For example, for the R-Z scale, Ricky was given the highest rank (1), and Kevin was given the lowest rank (9). Similarly, for the Fine Motor subscale of the C-A scales, Ricky was the highest-ranking child, and Kevin was the lowest. It was predicted that there would be a positive correlation between each scale (that is, a higher score on the Cognitive subscale would correlate with a higher score on the Fine Motor subscale, and vice versa); thus, a one-tailed test was used to determine the level of significance (Snodgrass, 1977). The results of the analysis are summarized in Table 3.

Each correlation coefficient score shows a positive relationship between the selected scales; that is, a higher score on scale x broadly correlates with a higher score on scale y, and vice versa. The correlation of + 1.0 between OSPD (Schemes) and ORSAP shows a perfect linear relationship between the two sets of data (significant at the .005 level). The second- highest correlation coefficient (0.97) was found between the R-Z Sensorimotor subscale and the C-A Fine Motor subscale. This finding was also significant at the .005 level and shows a high level of agreement between the results of these two procedures. The lowest level of agreement (0.91) was between the OSPD Schemes subscale and the C-A Fine Motor subscale, although this correlation was also significant at the .005 level.

In the following sections, the results are analyzed further. The features on which comparisons can be made across the case studies are explored with a particular focus on the three research questions outlined earlier.

Nature of haptic strategies

The first research question concerned the nature of the haptic exploratory strategies used by children who are visually impaired and have additional disabilities. The findings reported earlier provide evidence of a broad distinction between two groups of children in the sample. Group 1 consisted of four children (Ricky, Jess, Dave, and Aaron) who were assessed as functioning at least within Stage 4 of the sensorimotor period, as attaining a score of 9 or higher on the Sensorimotor subscale of the R-Z Scales, and as attaining a relatively high score on Fine Motor Development (as assessed on the C-A scales). Group 2 consisted of five children (Kevin, Gary, Jamie, Nicky, and Liz) who were assessed as functioning within Stage 1, 2, or 3 of the sensorimotor period, as attaining a score of 4 or lower on the Sensorimotor subscale of the R-Z Scales, and as attaining a relatively low score in Fine Motor Development.

A further analysis was conducted to compare significant features both within and across these two groups. Using the evidence from information collected for the assessment portfolio, I selected a number of broad categories of activity for comparison of each child's HBR: reach, prehension (grasp/release), holding, transfer, CBA, oral/hand, and actions.

The participants in Group 1 were characterized by evidence of a relatively wide range of haptic behaviors within their HBR. They all were observed reaching, prehending, holding, transferring, and engaging in CBA with objects. Furthermore, they all had been observed using their oral modality in combination with their hand while they manipulated objects (coded "oral/hand").

The characteristics of Group 2 had greater within-group diversity than did those of Group 1. Of the five participants in this group, three (Kevin, Gary, and Jamie) did not use their oral modality during their interactions with the objects, and four (Kevin, Gary, Jamie, and Nick) did not transfer an object. One participant (Liz) was observed performing a two-stage transfer, which involved both hands holding the object while supported in her mouth, prior to transfer. In addition, three participants (Nick, Jamie, and Gary) were able to prehend an object (grasp and release), while one (Kevin) was not observed independently prehending an object. Of particular note was the finding that none of the children in Group 2 was observed performing CBA. These findings are summarized in Table 4.

Exploratory strategies

The second research question was concerned with the extent to which haptic strategies could be identified as serving an exploratory (that is, information-gathering) function. The range and variety of haptic strategies observed across the case studies suggests that it is not possible to make direct links between the full range of haptic behaviors and the exploratory procedures (EPs) outlined by Bushnell and Boudreau (1991). However, behaviors were identified that were similar to the descriptions of certain EPs—for instance, squeezing or poking an object (pressure EP), banging or tapping an object (unsupported holding EP), and rubbing with a finger (lateral motion EP). In addition, a number of patterns of movement were identified which, although they did not resemble particular EPs in their superficial appearance, may have served a similar function (that is, they could be interpreted as having a possible functional equivalence). For example, Dave was observed rubbing an object onto the surface of his lip, a behavior that is not included in the model of early haptic development outlined by Bushnell and Boudreau. This behavior may have enabled Dave to gather information about certain properties of the object (for example, surface texture and temperature) and, in some respects, may have had functional equivalence with those behaviors linked with the lateral motion EP. Examples of other types of observed haptic behaviors and their possible functional equivalence are listed in Table 5.

In analyzing the haptic movements of the nine participants, I found that a broad distinction emerged between the range and type of haptic activity performed by the children with no physical restrictions in their manual abilities (Aaron, Jess, Gary, Nick, Dave, and Ricky) and that performed by the children with restrictions that served to limit their physical interactions with objects (Liz, Jamie, and Kevin). An example of this distinction was observed with Liz, whose interactions with objects were significantly limited by her severe spastic quadriplegia. Although Liz was not able to reach and grasp an object independently, once the object was placed in her clenched palm, she was nevertheless observed performing a variety of actions with objects (for example, tapping beads against her teeth) in ways that *may* have had an information-gathering function. There are parallels here with the "executive" and "information-gathering" actions of the hands noted by E. J. Gibson (1988) that are explored further in the Discussion section.

Assessment approach

The third research question was concerned with the type of assessment approach that may be the most appropriate for identifying and analyzing the observed haptic strategies. The scales selected for the assessment portfolio were found to offer useful reference points against which to compare certain patterns of haptic activity with typical development. However, despite relatively high correlations in the ranked scores among the scales when measured across the case studies, at the level of the individual participants, particular issues were raised in attempting to code a number of the observed haptic behaviors reliably. Overall, the findings highlight the diversity of behaviors within the sample and show that each scale that was selected for the assessment portfolio in isolation was not sensitive enough to code the full range of observed activities across children who are visually impaired and have additional disabilities. This diversity gives rise to a related research question: To what extent can a sufficiently broad model of assessment be structured to account for the range of haptic activities within this population of children? This question is now considered further in the Discussion section.

Discussion and implications

As was noted in the review of the literature, there is a relative dearth of research on the role of haptic perception in the learning and development of children with visual impairments and additional disabilities. This study, with a particular focus on the haptic exploratory procedures used by such children, adds to the emerging literature in this area. The findings offer support for the results of earlier studies (for example, Nielsen, 1988; Rogow, 1987) that highlighted the importance of haptic function when planning educational programs for children with visual impairments and additional disabilities.

However, the results provide evidence that assessments of haptic function that are based purely on those behaviors observed in typically developing children are insufficient to account fully for the diversity of observed haptic activity among the participants and that a broader approach to the assessment and analysis of haptic behaviors is required. The form that such an approach to assessment should take is not clear, although the findings of this study confirm that the analysis of haptic behavior in visually impaired children who have additional disabilities needs to be viewed within a broader framework to account for the range of variables that may influence each child's haptic interactions than the variables that were used in this study. In developing such a framework, reference is made to the adaptive-tasks framework outlined by Warren (1994).

The adaptive-tasks framework considers sources of variance in the development of children, grouping variables that are common to all children in "adapting to the tasks of existence" (for example, the physical world and cognitive skills) and those variables that are specifically related to visual impairment (for example, age of onset of the visual loss, degree of functional vision, and additional impairments). The approach is designed to account for the dynamic interplay between a child's capabilities and the circumstances provided by the environment over the course of development and in identifying and organizing the set of adaptive tasks. Warren (1994) stated that reference needs to be made to (1) accounts of typical development in sighted children, (2) an analysis of each adaptive task in the context of visual loss (for example, how a child uses his or her haptic abilities to engage with an object), and (3) an evaluation of the relevant literature.

It is acknowledged that an adaptive-behavior approach is not without limitations. Indeed, it has been described by Frankenberger and Harper (1988), for example, as being "loosely defined," "difficult to measure," and open to "subjective interpretation." Furthermore, in the model outlined by Warren (1994), there is no indication of *how* the "dynamic interplay" between the child and the environment is to be interpreted or *who* should be involved in this interpretation. Despite these limitations, an adaptive-behavior approach may be able to provide sufficiently broad parameters within which to interpret sources of variance in the developing haptic abilities of individual children who are visually impaired and have additional disabilities. It is recommended that further research be conducted to explore its possibilities.

Although this study was not intended as an "intervention" study, the findings suggest a number of implications for educators. For example, the links made by Bushnell and Boudreau (1991) between early haptic behaviors and related exploratory procedures may offer a useful frame of reference for analyzing a child's haptic movements when the child is engaged with different types of objects and objects with different properties. Observing how a child engages with balls of different shapes, sizes, and textures can provide valuable information on the types of exploratory movements that the child is able to perform with objects with different properties, which, in turn, can provide a helpful foundation for structuring the child's experiences to develop further the child's knowledge and understanding of objects and their sensory features (McLinden & McCall, 2002).

As was noted earlier, the distinction that E. J. Gibson (1988) made between the executive and perceptual functions of the haptic system can be useful to educators in developing a child's haptic abilities. An example was given of Liz, who, despite severe restrictions in her independent manual abilities, was able to perform a number of actions on objects once the objects were appropriately positioned in her hand. This distinction suggests that careful thought needs to be given to providing children with opportunities to perform executive actions with objects (both independently and with additional support) as a means of enabling them to change the affordances of objects *independently*, thereby providing them with new occasions for gathering information and for acquiring knowledge (McLinden & McCall, 2002). As E. J. Gibson (1988) noted, as new actions become possible, new affordances are brought about, and both the information available and the mechanisms for detecting this information increase.

This suggests a key role for those who are involved in supporting and developing the haptic learning experiences of children with visual impairments and additional disabilities. Although the focus of this study was primarily concerned with the haptic movements of children with visual impairments and additional disabilities, the findings suggest a key role for those who are involved in supporting and developing their haptic learning experiences. As McLinden and McCall (2002) noted, a common feature of these children is their greater dependence on others to structure their learning experiences, with effective learning through touch rarely taking place within a social vacuum. Indeed, if exploratory movements serve as "windows" through which the haptic system can be viewed, as Lederman and Klatzky (1987) stated, professionals in the field need to pay careful attention to these movements to gain insights not only into the abilities of children who are visually impaired and have additional disabilities, but into their own role in ensuring that each child is afforded opportunities to engage with objects to the best of his or her unique and distinctive abilities.

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