JVIB

August 2004 • Volume 98 • Number 8

Research Report

Exploratory Behavior: A Comparison of Infants Who Are Congenitally Blind and Infants Who Are Sighted

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This research was funded by the President's Research Investment Fund of Central Michigan University. The authors thank Michael Rao for grant support; Christie Nutkins for assistance with data collection; Jungsywan Sepanski for help with data analysis; Beth Rutz, Susan Lagendonk, Nancy Camburn, Belinda Voelschow, Midge Horton, and Linda Bell for their help in locating children; and the families of infants who participated in this research.

Exploratory behavior has long been considered an important means by which infants obtain information about the environment and develop cognitively (Caruso, 1993; Gibson, 1987). Exploration includes

many behaviors, such as mouthing, rotating, shaking, and looking. As a result of using these behaviors, infants perceive the characteristics of objects, such as size, temperature, hardness, texture, and shape (Bushnell & Boudreau, 1991; Ruff, 1989).

A number of studies have examined the exploratory behavior of sighted infants, but few of these studies have explored the behavior of infants who are blind (for an exception, see Schellingerhout, Smitsman, & Van Galen, 1998). Infants who are blind cannot see the effects of their actions on objects, that objects exist even when out of reach, or what others do with objects (McConachie & Moore, 1994). Bigelow (1992) suggested that infants who are blind know less about objects and space than do sighted infants.

Research on the exploratory behavior of infants and young children, both sighted and blind, has suggested that there are both similarities and differences in their development. Regarding similarities, Landau (1991) studied three children, aged 18–36 months, who were congenitally blind and found that they, like sighted infants, used fingering to explore textures and rotation to examine the shapes of objects. In a review of the literature, Schellingerhout et al. (1998) studied eight infants aged 9–22 months who were congenitally blind and noted that, like sighted infants, these infants adapt their exploratory behaviors to correspond with the characteristics of the objects they are examining.

Regarding differences, Bigelow's (1992) study of three children aged 13–32 months who were blind found that the children were delayed in reaching for objects compared with data from other studies of sighted children. Smitsman and Schellingerhout (2000) observed that infants who are blind display little or no touching of nearby surfaces as compared to sighted infants. Schellingerhout et al. (1998) suggested that infants who are blind display fingering of objects later than do sighted infants and show a prolonged use of mouthing.

Because of the limited number of studies with infants who are blind, many questions remain regarding how blindness affects infants' exploration of objects. Furthermore, few studies have included both infants who were blind and sighted infants. To gain a better understanding of the development of exploratory behavior for both groups, further research is warranted.

This study examined exploratory behaviors used by infants who were congenitally blind and infants who were sighted to note similarities and differences in exploration. By including both groups of infants and matching the infants by age and their mothers' education, we could make direct comparisons between the groups.

Method

Participants

The participants included 12 infants who were congenitally blind from California, Iowa, Michigan, and Wisconsin and 12 sighted infants from Michigan who were matched by age and mother's education with the blind infants. According to their mothers and teacher consultants, the infants who were blind had no other disabilities and little or no useful vision. One child who was blind was born three months premature and was matched on her corrected, rather than her chronological, age. The children who were blind were recruited through consultants for children with visual impairments in school districts and private, nonprofit programs for children who are blind. The sighted infants were selected from a database of two previous studies.

The 12 infants who were congenitally blind (8 girls and 4 boys) ranged in age from 12 to 23 months (M = 17.2, SD = 3.9). One child was African American, 2 were Hispanic American, and 9 were white non-Hispanic. Of the 12 children who were blind, 1 each had aniridia and nystagmus, hypopituitarism, Leber's congenital amaurosis, microphthalmia and anophthalmia, septo-optic dysplasia, microphthalmia and retinopathy of prematurity, nystagmus and hyperopic astigmatism, and retinopathy of prematurity, and 4 were diagnosed with optic nerve hypoplasia. Two mothers had less than a high school education, 5 were high school graduates, 2 had completed technical school or several years of college, and 3 were college

graduates.

The sighted infants (5 girls and 7 boys) ranged in age from 12 to 23 months (M = 16.8, SD = 4.0). All were white non-Hispanic. Their mothers' levels of education matched those of the mothers of the infants who were blind.

Apparatus

A JVC digital videotape camera with a 40.5 mm lens was used to record the infants' exploratory behaviors. The camera was mounted on a tripod and located approximately 2 meters (about 6 ½ feet) from the child. A stopwatch was used to record the trials for the presentation of objects.

Objects were selected to evoke different behaviors. Thus, items of various shapes, sizes, textures, and hardness were presented one at a time for exploration. These objects and their sizes (in inches) were as follows: a yellow plastic car (2 × 1.5 × 3); a cotton ball (1 × 1 × 1); a yellow, rubber squeaky bear (2 × 5 × 3); a white, plastic windup musical toy that played a lullaby (3.5 × 2 × 4); a brown plastic maraca (3 × 3 × 10); a black-and-white rattle with three plastic links attached (4 × 3 × 1.5); and a soft, green cloth dog ball that talked when it was moved (4 × 3.5 × 4).

Procedure

Each infant was seated on his or her mother's lap at a

table. The mothers were instructed to sit as still as possible and not to interact with their infants while the objects were being presented. A researcher sat on the opposite side of the table to time the trials and to pick up toys that were dropped, thrown, or moved out of reach. Testing took place either in the infant's home or in an infant or preschool program. A second researcher was present to videotape the trials.

The infants were presented with the seven objects, each for one minute, and their performance was videotaped. The researcher placed each item so that it touched the infant's hand when it was presented. If an item was dropped, thrown, or moved out of reach, either the mother or the researcher returned the object to the infant for the duration of the trial.

Each item was assigned a number, and a roll of the die determined the order in which the items were presented. The same order was used for each infant: the car, cotton ball, squeaky toy, musical toy, maraca, rattle, and dog ball. Intertrial intervals were approximately five seconds. If an infant became upset during the trials, the mother was asked to calm him or her. Once the infant was calm, the trial continued.

Dependent variables. The first 50 seconds of each 1-minute trial were coded. Because toys were occasionally exchanged at 59, rather than 60, seconds, the last 10 seconds of each trial were not coded. Partial interval coding was used to record the infants' behavior

during the first 50 seconds of each 1-minute trial. For each of the five 10-second intervals, a plus was recorded on the data sheet if a behavior was observed at any time during the interval, and a zero was recorded if a behavior was not observed. Definitions of the 12 exploratory behaviors that were coded appear in Box 1.

Reliability. Two observers independently coded the videotapes to evaluate interobserver reliability for three children who were randomly chosen from each group. Reliability was evaluated for each behavior in terms of agreements divided by agreements plus disagreements. Agreement was recorded when both observers coded a behavior as occurring or not occurring during an interval. The mean percentages of agreement for each behavior ranged from 86% to 99%.

Results

Behaviors involving the face and mouth were displayed infrequently. Across the seven objects, mouthing averaged 0.35 intervals for the infants who were blind and 0.23 for the sighted infants; use of the facial area averaged 0.49 intervals for the infants who were blind and 0.10 for the sighted infants.

Data for nine other exploratory behaviors that primarily involved the hands are shown in Figure 1. Pulling apart was not included because it could occur only for the cotton ball. Hands-on contact was observed for almost all intervals for all the infants in

both groups, and fingering occurred in approximately two of the five intervals on average.

To compare the exploratory behavior of the two groups of infants, the data were collapsed across the seven objects. Because only the cotton ball could be pulled apart and only three objects (the squeaky toy, dog ball, and cotton ball) could be squeezed, these two behaviors were analyzed only for the toys for which they were relevant. An analysis of variance (ANOVA) revealed that only 1 of the 12 behaviors was significantly different. The sighted infants pushed the objects more often than did the infants who were blind, F (1,22) = 6.03, p = .025.

An ANOVA was used to compare the groups on each behavior for each object. Because of the number of analyses, an alpha level of .025 was used. Only three significant differences were found. The infants who were blind dropped the maraca more than did the sighted infants, F (1,22) = 5.80, p = .025; the sighted infants fingered the music box more than did the infants who were blind, F (1,22) = 6.32, p = .02; and the infants who were sighted pushed the car more than did the infants who were blind, F (1,22) = 7.37, p = .02.

Ten of the 12 behaviors could be used with all seven objects. However, pushing was the most appropriate for the car with wheels, and shaking was the most appropriate for the rattle and maraca because of the

effects of these behaviors on these three toys. To determine whether the infants recognized these affordances, pushing the car was compared with pushing other objects, and shaking the rattle and shaking the maraca were compared with shaking other objects.

The comparisons indicated that the mean number of intervals in which the maraca and rattle were shaken were 2.2 and 1.2, respectively, versus a mean of 0.2 for shaking the other five objects. A 2 Group (blind versus sighted infants) by 2 Object (rattle versus car, cotton ball, squeaky toy, music box, and dog ball) repeated-measures ANOVA indicated that there was a significant main effect only for the objects. Both groups shook the rattle more than the other five objects, F (1, 22) = 16.16, p = .001. A 2 Group by 2 Object repeated-measures ANOVA indicated that the infants shook the maraca more than they did the other objects (the car, cotton ball, squeaky toy, music box, and dog ball), F (1,22) = 32.06, p = .001.

Comparisons for pushing indicated that the car was pushed for a mean of 1.2 intervals, compared with 0.1 interval for the other objects. A repeated-measures ANOVA for pushing the car indicated a main effect for Group, F (1,22) = 7.55, p = .01, and for Object, F (1,22) = 13.84, p = .001, as well as a significant interaction, F (1,22) = 7.02, p = .02. The sighted infants pushed the car more than they did the other objects, as well as more than did the infants who were

blind.

Discussion

This is the only study in which the exploratory behavior of both infants who were congenitally blind and sighted infants was investigated. Matching the infants on their ages and their mothers' educational levels allowed us to compare the two groups and eliminated some possible confounding variables.

No differences were found between the two groups for 11 of 12 exploratory behaviors. The only behavior that was significantly different was pushing. Thus, the development of many exploratory behaviors was found not to be dependent on vision. These results support Landau's (1991) finding that three 18- to 36-month-old children who were congenitally blind explored the texture and shape of objects using the same behaviors as those reported for sighted children. Morrongiello, Humphrey, Timney, Choi, and Rocca (1994) also found that 3- to 8-year-old children who were blind and those who were sighted did not differ on tactile exploration and object recognition.

Although some infants who were blind pushed the car, the sighted infants pushed it more. Perhaps infants who are blind are not prompted to push objects as much as are sighted infants or, perhaps because of their vision loss, they need more practice. Pushing may not be an important developmental difference, but it may be

worth more attention to enhance play skills. The infants who were blind dropped the maraca more than did the sighted infants. The maraca was the largest toy and was weighted more heavily on one end.

Swanson, Bradley-Johnson, and Johnson (2004) used the same procedure with sighted infants aged 6–18 months. They found that the only behavior to correlate with intelligence, measured by the Cognitive Abilities Scale—Second Edition (Bradley-Johnson & Johnson, 2001) was hands-on contact (r = .49; r_c = .61, corrected for restricted range). Thus, hands-on contact appears to be related to cognition, and no significant group differences were found for this behavior in the current study.

For sighted infants, mouthing tends to decrease by 11 months (Ruff, Saltarelli, Capozzoli, & Dubiner, 1992). Schellingerhout, Smitsman, and Van Galen (1997) noted that it is sometimes assumed that infants who are blind tend to mouth objects longer. However, the infants in the current study were aged 12–23 months, and little mouthing was evident for either group.

Consistent with the findings of Schellingerhout et al. (1997), both groups of infants used a wide range of behaviors to investigate objects. Caruso (1993) found that the breadth of exploratory behaviors that infants use is predictive of successful problem solving. Thus, the use of a range of exploratory behaviors, rather than the repetitive use of a few, appears to be beneficial for

learning.

Lederman and Klatzky (1987) concluded that as their exploratory behaviors develop, infants use specialized behaviors that are appropriate for different properties of objects. For example, Schellingerhout et al. (1998) observed that infants who were blind used behaviors that fit the characteristics of a key fob (swinging) and a toy car (pushing). In the present study, both groups used exploratory behaviors that fit the characteristics of particular objects; for example, they shook the rattle and maraca more than they shook other objects, and they pushed the car more than they pushed other objects.

These results should be interpreted in light of some limitations. Although the mothers and teacher consultants reported that the infants who were blind had no additional disabilities, some may have had other unrecognized developmental delays. However, the fact that no differences were found between the groups on 11 of 12 behaviors suggests that the infants who were blind did not have other severe disabilities. Another concern is the sample size. Although this study had a larger sample than did other studies, 12 per group is relatively small. The difficulty locating infants who are blind without other disabilities makes it hard to obtain larger samples.

In summary, our results are consistent with those of Schellingerhout et al. (1997), that infants who are

congenitally blind use as wide a range of exploratory behaviors as do sighted infants. Even when the two groups of infants were matched by age and their mothers' education, no significant group differences were evident for 11 of 12 behaviors. No difference was found even for mouthing, a behavior that is sometimes assumed to be used for a relatively prolonged period by infants who are blind. The behavior of hands-on contact with objects, which correlates with cognitive development for sighted infants (Swanson et al., 2004), showed no group differences. Moreover, it was clearly the most frequently used behavior for both groups. Furthermore, both groups of infants used behaviors that fit particular features of objects, such as pushing a toy car but rarely pushing objects without wheels. Replication of this study, including an examination of exploratory behaviors used at different ages by children who are congenitally blind, should provide information that will help researchers gain further knowledge of the development of these children's exploratory behavior.

Because of the similarities that were found between the two groups of infants, these findings should be encouraging for parents of infants who are blind, as well as for professionals who work with these families. The infants who were blind used 11 of the 12 exploratory behaviors as frequently as did their sighted peers. The implication of this finding is that generally these types of exploratory behaviors do not require direct instruction for infants who are congenitally

blind. As with sighted infants, some infants who are blind may be passive and, therefore, benefit from physical guidance to encourage exploration. Another implication is related to the selection of toys for infants who are blind. Providing infants who are blind with a variety of toys and other objects so that they have the opportunity to practice using the wide range of exploratory behaviors in their repertoire will be beneficial.

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