Objective. The purpose of this study was to determine whether switch control site (hand vs. head) affects the age at which children can successfully activate a computer to play a cause-and-effect game.

Method. The sample consisted of 72 participants randomly divided into two groups (head switch vs. hand switch), with stratification for gender and age (9–11 months, 12–14 months, 15–17 months). All participants were typically developing. After a maximum of 5 min of training, each participant was given five opportunities to activate a Jelly Bean switch to play a computer game. Competency was defined as four to five successful switch activations.

Results. Most participants in the 9-month to 11-month age group could successfully use a hand switch to activate a computer, and for the 15-month to 17-month age group, 100% of the participants met with success. By contrast, in the head switch condition, approximately one third of the participants in each of the three age ranges were successful in activating the computer to play a cause-and-effect game.

Conclusion. The findings from this study provide developmental guidelines for using switches (head vs. hand) to activate computers to play cause-and-effect games and suggest that the clinician may consider introducing basic computer and switch skills to children as young as 9 months of age. However, the clinician is cautioned that the head switch may be more difficult to master than the hand switch and that additional research involving children with motor impairments is needed.

Infants who are typically developing learn quickly that if they cry, someone will feed them or pick them up. As they gain more control over their bodies, they learn that if they reach for a toy, they can touch it; if they pull a string, they can obtain a toy attached to it; if they hit a tower of blocks, it will fall over. Through such experiences, children begin to develop an awareness of cause-and-effect relationships. There is some controversy in the literature as to the age and manner in which children develop an understanding of such relationships.

Literature Review
Piaget (1952) believed that the awareness of cause-and-effect relationships primarily was developed during Stages III through V of the sensorimotor period. According to his theory, during Stage III (4–8 months), behavior is repeated to achieve an effect on an object; during Stage IV (8–12 months), children engage in an active search for cause-and-effect relationships; and during Stage V
(12–18 months), children explore different means for achieving the same goal, but they still must physically solve a problem to understand cause-and-effect relationships (Schuster, 1992). Thus, according to Piaget, the awareness of cause and effect develops from 4 to 18 months via the motor actions the infant makes in his or her world. After conducting a review of literature describing the emergence of awareness of cause-and-effect relations, Brinker and Lewis (1982) concluded that infants develop a sense of cause and effect by physically interacting with their environments and experiencing consistent reinforcements for their physical actions.

Children with severe motor impairments are limited in their ability to cause physical changes in their environments. Theoretically, because of their limitations, these children may not learn that their actions can produce changes and that the environment is controllable. They are, therefore, at risk for developing learned helplessness (Abramson, Seligman, & Teasdale, 1978; Brinker & Lewis, 1982; Langley, 1990; Reeson & Ryan, 1988, Robinson, 1986; Van Tatenhove, 1987). “Learned helplessness is the perception that one cannot control the outcomes that he or she experiences” (Weisz, 1979, p. 311). Several authors believed that the condition of learned helplessness is reflected by a dependency on others to fulfill one’s needs, a lack of motivation, and passive interactions with the environment (Abramson et al., 1978; Brinker & Lewis, 1982; Langley, 1990; Lewis & Vulpe, 1986; Parette & Van Biervliet, 1990; Reeson & Ryan, 1988; Robinson, 1986; Van Tatenhove, 1987). Abramson and colleagues maintained that if the child learns that his or her actions will not produce a response, he or she is less likely to repeat the action in the future. Because the child is not reinforced for his or her actions, it appears that a cycle develops in which the child makes them with less frequency until becoming passive and dependent on others.

According to Robinson (1986), learned helplessness can be well established by the time a child is 4 years old. Many researchers wrote that learned helplessness is well established by the time children with disabling conditions begin school (Behrmann & Lahm, 1984; Brinker & Lewis, 1982; Reeson & Ryan, 1988). Thus, in an effort to prevent or decrease the effects of learned helplessness, it seems that intervention should occur at as young an age as possible.

Assistive technology allows a person with a disability to perform actions that persons without disabilities can do without assistance. Assistive technology devices can use the person’s available motor ability to produce larger, goal-directed changes in the environment. It may allow young children with motor impairments to establish an understanding of cause-and-effect relationships, exert some control over their environment, and lessen their risk of developing learned helplessness. Though the literature suggests that assistive technology can be a viable means of allowing children and adults with motor impairments to exert control over their environments (Butler, 1986; Butler, Okamoto, & McKay, 1983, 1984; Douglas & Ryan, 1987; Einis & Bailey, 1990; Lewis & Vulpe, 1986; Robinson, 1986; Wright & Kohn, 1993), few studies have investigated its use with infants and toddlers.

Swithin, Anson, and Deitz (1993) demonstrated that most typically developing infants were able to control a simple cause-and-effect computer game at the age of 7 months. In contrast, of the 10 children between the ages of 6 and 7 months, only 3 were able to master the task. This study supported the idea that children in Piaget’s (1952) Stages IV and V of the sensorimotor period can use computer technology to explore cause-and-effect relationships.

One of the primary challenges for the therapist is to determine the age or developmental level at which to introduce the computer to the child as a means of gaining some control over the environment. The therapist must also determine the most effective motor site for the child to elicit that control. In the Swinth et al. (1993) study, each infant was positioned in front of a computer screen and used a hand switch positioned within his or her visual field to produce music and a smiling face on cue. Although hand switches are the “natural” control mechanism for such programs, children with major motor impairments may not be able to use a hand switch to control assistive technology devices. These children must use a switch that they can control, regardless of the part of the body used. The literature describes the use of motor sites other than the hand to control assistive technology devices. For example, Everson and Goodwyn (1987) described children using hands, heads, or feet to activate microswitches to operate microcomputers, and Realon, Favell, and Dayvault (1988) described persons using elbow, wrist, and leg switches to activate leisure devices.

Because switch control site may vary depending on the motor capabilities of the child, it is important to know whether switch control site affects the age at which children can activate a computer to play a cause-and-effect game. Therefore, the purpose of this study was to determine the effects of switch control site (hand vs. head) on the acquisition of computer skills of young, typically developing children. For each of three groups (9–11 months, 12–14 months, 15–17 months), the fol-
lowing research questions were addressed:

• What percentage of participants demonstrated competency when using a head switch to play a computer game?
• What percentage of participants demonstrated competency when using a hand switch to play a computer game?

In addition, the following question was addressed for each age group to describe the participants’ behavior during testing:

• What percentage of participants maintained a testable behavioral state throughout the entire experimental session?

Method

Participants

The convenience sample consisted of 72 infants and toddlers who were typically developing and residing within the greater Seattle area. Typically developing was defined as a child who was born within 4 weeks of due date, had no known physical disability, had no known visual deficit, had no known hearing impairment, and had a score of normal on the Denver II (Frankenburg et al., 1990). Participants were recruited through a variety of sources, such as cooperative preschools, community centers, day-care centers, physicians, and parenting magazines and newsletters. In compliance with University of Washington human subjects requirements, all parents provided consent before data collection.

The participants were divided randomly into two groups (hand switch and head switch), with stratification for age and gender. Thus, each of the two major groups had 36 participants, with 12 (6 boys and 6 girls) in each age group. Group 1 consisted of participants ranging in age from 9 months 0 days to 11 months 30 days; Group 2 consisted of participants ranging in age from 12 months 0 days to 14 months 30 days; and Group 3 consisted of participants ranging in age from 15 months 0 days to 17 months 30 days.

A parent questionnaire was used to collect demographic data regarding the participants and their parents. The questionnaire contained items related to inclusion criteria for participants and explored whether the participants had experience with computers or cause-and-effect toys and whether they were crawling or walking. Parents were also asked a series of questions regarding the activity preferences of their child. The responses for each participant were combined, and a final activity preference designation (i.e., gross motor, neutral, fine motor) was made (see Table 1).

The majority of the participants were of Caucasian background. Sixty-five of the participants’ mothers were Caucasian, two were African-American, one was Native American, and four were Asian. Sixty-four of the participants’ fathers were Caucasian, two were African-American, one was Hispanic, three were Asian, and one was East Indian. Information on the ethnic background of one father was not available. Parent education varied. Of the mothers, 35% had a bachelor’s degree; 31% had a graduate degree or graduate education; 22% had a high school diploma, had completed some college coursework, or both; and 12% did not have a high school diploma. Of the fathers, 40% had a graduate degree or were in graduate school, 31% had a bachelor’s degree, 14% had some college experience, and 15% had a high school diploma.

Apparatus

The computer system, an Apple IIGS equipped with an Apple 13-in. color monitor1, was selected for this study for two reasons. First, the color monitor produces clear graphics, which are believed to be attractive to children. Second, a variety of adaptive access systems are available for use with this system, making it easy to adapt for children with disabilities.

The Jelly Bean switch2, a plastic, pressure-sensitive switch, was used at the hand and head control sites. This switch is activated by less than 2 oz of pressure. The switch used in this study consisted of a 2-1/2 in. diameter green disk centered on a 3-1/4 in. diameter black disk. A dark green color was chosen to be attractive to the participants but not too distracting. The Jelly Bean switch provided minimal tactile feedback to the participants but produced an audible click when pushed. It was connected to the computer through the joy-stick port.

“Switches, Pictures and Music II” (Anson & Swinth, 1990), an adapted version of “Switches, Pictures and Music”3, was used in this study. This cause-and-effect program allows children to activate a switch to make a picture, accompanied by a song, appear on the computer screen. Two versions of this program were used. The first

1Manufactured by Apple Computers, Inc., 20525 Mariane Avenue, Cupertino, California 95014-6299.
2Manufactured by AbleNet Inc., 1081 Tenth Avenue SE, Minneapolis, Minnesota 55414-1312.
3Manufactured by Colorado Easter Seals, 5755 West Alameda Avenue, Lakewood, Colorado 80226.
Table 1
Characteristics of Participants in Head Switch and Hand Switch Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Primary Mode of Locomotion</th>
<th>Experience to Computer</th>
<th>Exposure to Cause-and-Effect Toys</th>
<th>Activity Preference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crawling</td>
<td>Walking</td>
<td>Exposure to Computer</td>
<td>Exposure to Motor</td>
</tr>
<tr>
<td>Head switch</td>
<td></td>
<td></td>
<td></td>
<td>Motor</td>
</tr>
<tr>
<td>1. 9-11 months</td>
<td>9</td>
<td>1</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>2. 12-14 months</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>3. 15-17 months</td>
<td>0</td>
<td>12</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Hand switch</td>
<td></td>
<td></td>
<td></td>
<td>Neutral</td>
</tr>
<tr>
<td>1. 9-11 months</td>
<td>11</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2. 12-14 months</td>
<td>1</td>
<td>11</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>3. 15-17 months</td>
<td>0</td>
<td>12</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

*N = 72 with n = 12 for each age group

Two children in this group were not yet crawling.

version was used to teach the participants how to activate the switch. The second version, used during testing, was identical to the first except for the addition of visual cues for the data collector. These cues consisted of a backslash (\) that appeared at the bottom right corner of the screen if the switch was not activated within 10 sec. If the switch was not activated after 20 sec, an asterisk (*) appeared at the bottom right corner of the screen. Both cues were small and unobtrusive compared with the visual stimuli provided by the game itself.

A regular high chair with a tray was used to position the participants. The chair was centered in front of the computer monitor. The monitor was no more than 18 in. away from the participant, and the center of the screen was at the participant’s eye level. The parent and data collector were seated on chairs to the left and right of the participant.

In the hand condition, the switch was positioned at the participant’s midline, within 3 in. of the tray edge nearest the participant. A piece of cardboard was cut to cover the metal high chair tray. The switch was screwed into the center of this cover, which was attached to the tray with hook-and-loop straps. The switch could be activated by the participant pushing it with either hand.

In the head condition, Ablenet’s Universal Mounting System was used to position the switch so that it was (a) approximately 1 in. away from the participant’s head and centered at the occiput (widest part of the head) and (b) out of the participant’s line of vision. The participant could activate the switch by moving his or her head backward until it came in contact with the switch.

### Procedure

#### Pilot Study

A pilot study of six participants, two from each age group, was conducted before data collection. Observations made during the pilot study were used to determine optimum placement of the head and hand switches, height of the computer screen, and distance of the high chair from the computer screen. Originally, the head switch was placed on the right side of the high chair. All the pilot participants, even though they were harnessed in the chair, managed to turn far enough to see the switch and then proceeded to activate it with their hands. Hence, the switch was moved behind their heads so that they could no longer see it. With the switch out of view, the participants no longer attempted to activate it with their hands.

The hand switch was initially attached to the metal high chair tray with hook-and-loop straps. Several pilot participants were distracted by the screw holes in the border of the switch and seemed to enjoy banging on the tray more than attending to the computer game. As a result, a cardboard tray cover was fabricated, and the switch was screwed into the tray cover. This adaptation eliminated the distraction of the screw holes and lessened the noise made by banging on the tray, which seemed to make banging less attractive to the participants. Data from the participants in the pilot study were not included in the results.

#### Evaluation of Procedural Consistency and Interrater Agreement

All data were collected by the primary investigator, an occupational therapist with 4 years of pediatric experience. To establish procedural agreement, the data collector ran the session while one of two observers evaluated...
her performance with a data collection protocol form specifically designed for this study. The observers were occupational therapists with extensive pediatric experience who had familiarized themselves with the data collection protocol by observing the primary investigator during at least three of the pilot study sessions and by studying the data collection protocol form. Procedural agreement (Billingsley, White, & Munson, 1980) was calculated as percent of adherence to the items on the data collection form. Key items required 100% agreement. Procedural agreement checks were completed six times during the course of the study. Overall agreement of 95% was achieved, and 100% agreement was achieved on the key items.

Interrater agreement was established by having the observer time the practice session and score the testing session along with the data collector. Timing of the training session to within 3 sec was considered adequate. Item-by-item percent agreement (Kazdin, 1982) was calculated for number of trials completed successfully by the participant. On all six occasions, agreement was 100% for both variables.

Experimental Sessions

Sixty-two participants were evaluated in the primary investigator's home; six were evaluated at their cooperative preschool; and four were evaluated in their own homes. The basic protocol and procedures used during the experimental sessions were adapted from those described by Swithin et al. (1993). In an effort to decrease demands placed on participants, changes were made in the protocol, which were administering the Denver II at the end of the session rather than at the beginning, decreasing from 4 to 3 the number of switch activations required to move from training to testing, and decreasing from 10 to 5 the number of switch activations required to demonstrate competency during testing.

The experimental sessions took approximately 30 min. Each participant was accompanied by one or both parents throughout the experimental session. The data collector described the testing protocol to the participant's parent and allowed time for the parent to read and sign the consent form. The data collector then established rapport with the participant (spending no more than 5 min) by playing with him or her with a variety of toys until the participant appeared to be comfortable with the data collector and testing environment.

Provided the participant was in a testable behavioral state, the training session began. If a participant moved out of a testable behavioral state, he or she was given a break of no more than 10 min. Behavioral state was defined as the participant's level of activity or arousal on the basis of an adaptation of the nine State Levels described in the Carolina Record of Individual Behavior (Simeonsson, Huntington, Short, & Ware, 1982). A testable behavioral state was defined as quietly or actively awake with diffuse motor activity of limbs, such as kicking with legs or banging with hands; open eyes; regular respiration; quietness; or content vocalizations, such as babbling, laughing, and talking. An untestable behavioral state was defined as drowsiness; eyes opening and closing intermittently; frequent relaxation followed by sudden jerky movements of the extremities or head; pushing or looking away from the task; refusal to sit in the testing high chair; diffuse motor activity of the entire body; irregular respiration; fussy or cranky vocalizations; or screaming or crying (with or without tears).

Training: Each participant was seated in the high chair in front of the computer screen. The switch was positioned according to the data collection protocol, and the participant was given 5 sec to explore the switch. The data collector and parent then gave the participant demonstrations, physical assistance, and verbal instructions as to how to activate the program by using the switch. The cue, "Make the picture come back, make the music play," was used along with other verbal cues during the training session. The parent provided assistance to the participant during the training session as well as suggestions to the data collector as to cues that would best enable the participant to learn the task. The switch was removed (a) after the participant activated it three times consecutively with or without verbal cues within 5 sec of each opportunity, (b) if the participant did not maintain the testable behavioral state, (c) if the participant stopped attempting to activate the switch, or (d) after 5 min had passed. The participant was then given a toy to play with for approximately 30 sec while the data collector changed to the test disk. If the participant was in the testable behavioral state, the training session began. If the participant was not in the testable behavioral state, the data collector gave the parent an opportunity to calm the participant.

Testing: The parent was instructed to provide no assistance to the participant before the switch was activated but to smile, cheer, and clap only after the participant successfully activated the switch. The participant was told to "make the picture come back, make the music play." If the participant did not activate the switch in 10 sec (coded by the \ on the computer monitor), the verbal cue was repeated. If after 10 more sec the participant still had not activated the switch (coded by the *), the data collector repeated the verbal cue and gently moved the participant's hand or head to activate the switch, coding it as an
unsuccessful switch activation. The testing session ended after five opportunities to activate the switch.

After the participant finished the computer task, the parent and data collector completed questionnaires regarding the participant’s interactions with the computer and the switch. Finally, the Denver II was administered on which all participants obtained scores of normal.

Scoring and Data Analysis

The data collector used a scale of 1 to 4 (1 = attended consistently; 2 = occasionally distracted, did not interfere with the task; 3 = occasionally distracted, did interfere with the task; and 4 = distracted) to keep track of the participant’s behavior during training and testing. Switch proficiency was measured on a scale of 1 to 3 (3 = 4 or 5 successful switch activations; 2 = 2 or 3 successful switch activations; 1 = 0 or 1 successful switch activation). Competency was defined as a proficiency score of 3.

Results

All participants in both the hand switch and head switch conditions were able to complete the entire experimental session (training and testing). Results are presented separately for the head switch and hand switch conditions in the following sections.

Head Switch Condition

Approximately one third of the participants in all three age groups demonstrated competency in the head switch condition (see Table 2). No developmental progression was noted, and there was no apparent difference in the overall performance of boys versus girls, except Group 1 (9–11-month-olds; see Table 3).

There did not appear to be a relationship between the median amount of practice time and the participants’ age (see Table 4). Five of the 12 participants in each age group lost interest in the activity before completing the 5-min practice time and did not demonstrate competency during the testing part of the session (see Table 5). Four of the 36 participants required a break during the training session but resumed training and completed the testing session. None of the participants who took a break achieved competency.

Hand Switch Condition

Results demonstrating the percentages of participants in each group who met criteria for success with the hand switch suggest a developmental progression, with 83% of the participants in Group 1 and 100% in Group 3 achieving proficiency (see Table 2). Compared with the head switch condition, more participants in each age group were able to demonstrate competency with the hand switch. As shown in Table 3, the overall performance of boys was similar to that of girls.

Unlike the head switch condition, the median amount of practice time was much longer for the 9- to 11-month-olds than for the 12- to 14-month-olds and 15- to 17-month-olds (see Table 4). As can be seen in Table 5, one participant in Group 1 and one in Group 2 lost interest in the activity before completing 5 min of training and did not demonstrate competency. All participants in Group 3 learned the task without losing interest during the training and demonstrated competency during the testing. One participant in Group 1 used all the training time and did not demonstrate competency. None of the participants in Groups 1, 2, and 3 who demonstrated competency used the entire 5 min of training time. No participants in the hand switch condition required a break during the training part of the session.

Discussion

The study results indicated that with a maximum of 5 min training, some participants as young as 9 to 11 months of age could successfully learn to use a head switch to play a simple computer game and that partici-
Table 4
Median Amount of Training Time With Head Switch and Hand Switch

<table>
<thead>
<tr>
<th>Group</th>
<th>Median Time in Seconds</th>
<th>Low-High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 9–11 months</td>
<td>243</td>
<td>60–300</td>
</tr>
<tr>
<td>2. 12–14 months</td>
<td>206</td>
<td>54–300</td>
</tr>
<tr>
<td>3. 15–17 months</td>
<td>277</td>
<td>90–300</td>
</tr>
<tr>
<td>Hand switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 9–11 months</td>
<td>128</td>
<td>31–300</td>
</tr>
<tr>
<td>2. 12–14 months</td>
<td>66</td>
<td>21–156</td>
</tr>
<tr>
<td>3. 15–17 months</td>
<td>84</td>
<td>14–180</td>
</tr>
</tbody>
</table>

*N = 72 with n = 12 for each age group

pants 15 to 17 months of age were no more successful than participants in the youngest age group at using the head switch. In contrast, the study demonstrated that most participants as young as 9 to 11 months of age could successfully use a hand switch to play a simple computer game.

Head Switch Condition

One third of the participants in the head switch condition demonstrated competency, and no developmental progression was noted in skill development or in the amount of training time needed in the three groups. Almost half of the participants in each age group began to lose interest before the 5-min training time was completed. If a participant lost interest in the task despite repeated attempts by the data collector to engage him or her in the activity, the training portion of the session was terminated by removing the switch. Though after a 30-sec break, all participants were able to attempt the testing portion of the experimental session, it is possible that they had not practiced long enough to learn the task. Alternatively, it is possible that some participants needed the switch to be in view to understand the cause-and-effect relationship between switch activation and consequent computer activation.

After the testing session was completed, the switch was moved into the participant's line of vision, and he or she was allowed to explore the switch. Even those participants who had been unsuccessful with the head switch condition readily activated the switch with a finger or whole hand when it was within their visual field. Most of the participants continued this action repeatedly, suggesting that the switch needed to be in view for them to understand that pushing the switch activated the computer game.

Hand Switch Condition

Compared with the participants in the head switch condition, the majority of participants in each age group demonstrated competency with the hand switch. Switch competency increased by age, with 100% of the participants in the oldest age group being successful. This finding is different from that of Swinth and colleagues' (1993) who found that 55% of participants from 9 to 14 months of age were successful, and 85% of participants from ages 15 to 17 months were successful. The testing protocol used in the present study was similar to that used by Swinth et al., except for the adaptations previously described. The shorter testing session (5 switch activation opportunities in the current study instead of 10 in the Swinth et al. study) may have lessened the participant's chance of becoming bored with the computer game before achieving a score reflecting competency. Another change in protocol was to administer the Denver II at the end of the session rather than at the beginning. Although the Denver II is a fairly noninvasive measure, the children in the present study may have been fresher when they began their interaction with the computer and thus better able to attend to the activity.

Another difference between the hand switch and head switch conditions relates to the amount of training time used. The majority of the participants in the hand

Table 5
Training Times and Participants' Performance With Head Switch and Hand Switch

<table>
<thead>
<tr>
<th>Group</th>
<th>Did Not Demonstrate Competency</th>
<th>Demonstrated Competency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lost Interest in Task Before 5 Min.</td>
<td>Used all 5 Min. Training Time</td>
</tr>
<tr>
<td></td>
<td>1. 9–11 months</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2. 12–14 months</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>3. 15–17 months</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Hand switch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. 9–11 months</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2. 12–14 months</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3. 15–17 months</td>
<td>0</td>
</tr>
</tbody>
</table>

*Number of children out of 12 for each age group.
switch condition did not require more than 3 min of training to achieve competency. In contrast, the majority of the participants in the head switch condition used more than 3 min of training time. Thus, the participants in the hand switch condition appeared to learn the task more quickly than those in the head switch condition, which supports the idea that the head switch was more difficult to use than the hand switch. Additionally, many of the participants who did not achieve competency in the head switch condition did not sustain interest for the full 5 min available for training. It is possible that the game was not motivating enough to hold the participant’s attention sufficiently for them to learn to use the head switch successfully. A more motivating game might result in sustained effort and success in learning to use the head switch. Alternatively, the participants’ limited interest may reflect the difficulty of the task rather than limitations in the program.

Clinical Implications

The study findings suggest that the clinician may consider introducing basic computer and switch skills to children as young as 9 months of age. Infants with moderate to severe disabilities may benefit from being introduced to computers to decrease the effects of learned helplessness, increase their independence and ability to interact with their physical environments, and increase their opportunities to interact with other children and adults. Several factors should be taken into account before implementing computer use into a child’s developmental program. The clinician should explore various switch activation sites to determine which is most functional for a particular child. However, if a child has the physical capability to use either a head switch or a hand switch, ideally, the hand switch should be tried first. If a child can only use a head switch, the clinician should realize that the task may be more difficult than a hand switch task, and the child may require more training time. Additionally, clinicians will need to adjust the learning demands of a computer activity to match the child’s ability to attend to a task.

Strengths and Limitations

Several strengths of this study were inherent in the design and procedures. First, to establish developmental guidelines for switch use, the performance of participants who were known to be typically developing was studied. All participants were carefully screened with the parent questionnaire and the Denver II to ensure that they were typically developing. At this stage in the research, if children with severe motor impairments had been studied, it would have been difficult to control for cognitive potential.

Second, the participants were randomly assigned to the two groups (head switch vs. hand switch). The effectiveness of the randomization was reflected in the similar distribution of mobility, exposure to computers, exposure to cause-and-effect toys, and activity level.

Third, the positioning of the participants in the high chair was effective. Even though a few participants appeared to dislike being confined in the chair, most, it was familiar, nonthreatening positioning device. The high chair was a good height in relation to the computer screen, and the tray placed a natural barrier between the screen and the keyboard as well as provided a play surface for use between the training and testing portions of the experimental sessions.

Having parents participate in the training session was both a strength and a limitation. The participants gained comfort from having their parents close by; however, the parents’ interactions with the participants were not standardized, and they may have motivated the participants to different degrees.

This study also was subject to limitations. First, because only children who were typically developing were studied, the therapist is cautioned about generalizing the results to children with disabilities because they may respond differently. Activating a computer may provide children with disabilities with a first opportunity to exert control over an object or to make something happen independently. They may be more motivated to learn to use a switch to play a computer game than children without disabilities because they may have limited ability to move and to interact with toys and other objects in their environments. Alternatively, children with disabilities may be less motivated to learn a computer task because of limited histories of success in self-initiated play.

Second, the participants were volunteered, and a large proportion of the parents were highly educated. Caution is therefore indicated in generalizing the results to the general population.

Future Directions

Use of computers and related technology is becoming widespread in our society as a whole, in the educational system, and in the field of occupational therapy. As occupational therapists fulfill the role of enabling persons to become as independent and functional as possible, it is important that empirical data continue to be gathered that demonstrate how computers and computer technology can be adapted for and used by infants and young
children with disabilities.

Other areas of future research are to continue to explore the effect on children’s performance of different switch placements (e.g., in view vs. out of view, hand vs. foot), access systems (e.g., keyboard, touch screen), software, and types of monitors (black and white vs. color). In addition, this study could be repeated with children with disabilities and, longitudinal studies could be conducted relating to (a) teaching cause and effect; (b) increasing control and independence; and (c) decreasing learned helplessness. Research in these areas would be beneficial for children with disabilities and their parents, for educators and health care providers, and for computer programmers and software developers.

Conclusion

This study suggests that most children who are typically developing and as young as 9 months of age can successfully use a hand switch to access a computer, and some children as young as 9 months can begin to use a head switch to access a computer. These findings lend support to therapists who want to incorporate computer activities into their therapy programs for very young children with disabilities. The introduction of computer skills to such children may foster more capability and independence and lessen the impact of learned helplessness. As computers continue to become more widespread and prevalent in our everyday lives, this and future research can provide professionals and families with guidelines as to when, how, and why to incorporate computers into the daily lives of infants and toddlers with disabilities. ▲

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