A Review of Evidence on Practices for Teaching Young Children to Use Assistive Technology Devices

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Published articles about assistive technology (AT) from 1980 through 2004 were reviewed to identify those that focused on infants and young children. A total of 104 articles about AT with infants and toddlers were identified, and of these, 23 reported practices for teaching switch activation (12), computer use (6), power mobility skills (4), or augmentative and alternative communication (1). A majority of the subjects were children with physical or multiple disabilities. Studies used group, single-subject, and case study reports. Only one study used random assignment to conditions. Across all devices, the primary teaching strategy was opportunity to access and use the device, either independently or with teacher or peer facilitation. For the most part, children learned to use the targeted device and gained competence in device use through practice.

Specialized interventions such as assistive technology (AT) are essential when early intervention services are provided in ways that promote participation in family and community activities and routines (Campbell, McGregor, & Nacik, 1994; Campbell & Wilcox, 2005; Mistrett, 2004). AT can help families support their children's development and learning and promote their participation in activities and routines in everyday settings (Campbell, 2004; Langone, Malone, & Kinsley, 1999).

AT consists of two interrelated components: (a) adaptations and devices and (b) services to identify adaptations and devices and teach children and families to use them successfully. Adaptations and devices range from readily available, off-the-shelf, generally low-cost devices to those with limited availability, designed to address specific issues of disability (Mistrett, 2001). Readily available items, those generally used by all young children, include bath seats, car seats, strollers, and other baby equipment as well as spoons and bowls, Velcro, and toys. These items are considered low tech. Specialized devices are generally more complex and include alternative and augmentative communication (AAC), highly specialized switch interfaces, power wheelchairs, computerized toys, and other devices not readily available for use by the general population. These specialized devices are considered high tech (Mistrett, 2004).

Services include design or identification of appropriate adaptations and devices (i.e., assessment) and strategies for teaching children and families (i.e., interventions). Some adaptations and low-tech devices such as special spoons or plates may not require an extensive amount of teaching; children and families may be able to use them easily within their activities and routines. However, for most devices to be used effectively, especially those high-tech devices not readily available, some level of instruction for the family and child is typically required (Long, Huang, Woodbridge, Woolverton, & Minkel, 2003).

Whereas a number of publications advocate for early use of AT with very young children and describe benefits, principles, and recommended practices (e.g., Mistrett, 2004; Stremel, 2005), only a small number of publications report empirical evidence about effective interventions for teaching children and families to use AT devices. We reviewed published articles to examine the empirical basis for use of AT with young children and families and to obtain an understanding of what is known about teaching children and families to use adaptations and devices successfully.

METHOD

We selected articles for our study that (a) had been published within the past 25 years (between 1980 and 2004) in peer-reviewed journals included in one of several in-

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terdisciplinary journal indices; (b) focused on the use of an AT device by infants or young children with disabilities or developmental delay; and (c) reported data about practices used to promote children's use of the device. We established lists of key authors and terms by reviewing current literature regarding the use of AT with infants, toddlers, and young children. We used the names of 17 authors who had published more than two articles about AT along with 50 search terms such as *AT devices, AT technology, mobility, communication,* or *play.* We searched the databases of Journals@OVID full text, MEDLINE, ERIC, PsychInfo, and CINAHL, which index journals from medicine, allied health, nursing, education, early childhood, early intervention, and related fields, for the years between 1980 and 2004 using these key author names and terms. The searches yielded 115 articles.

Two reviewers read each of the articles to verify a primary focus on infants and young children, birth through 6 years of age. We eliminated 11 articles from the pool of 115 because a majority of the children reported on were school aged. We read the remaining 104 articles to determine presence of empirical evidence about teaching practices, and 77 articles that did not report data about teaching practices were eliminated. These included non-data-based articles such as resource or position papers about AT (*n* = 13), descriptions of the use of AT with typically developing children (*n* = 17), and discussions about devices, general strategies for use, assessment practices, or models for use of AT (*n* = 36). An additional 11 articles reported descriptive data about the perspectives of parents, providers, or state agency personnel on AT devices and services but did not focus on effective AT use by children and families. We then summarized the years of publication for the 77 articles on AT practices and for the 27 empirical articles on effective teaching strategies for AT use.

We created a database to identify the key features of the 27 empirical articles. The database identified title, author, journal and citation, purpose, study type, description of subjects, independent variable, dependent variable, results, and level of evidence. The American Academy for Cerebral Palsy and Developmental Medicine's (AACPDM) Levels of Evidence Classification (AACPDM, 2005) was used to identify study type and classify level of reported evidence. The classification system used in this model is based on Sackett, Richardson, Rosenberg, and Haynes's (1997) evidence-based medicine classification system for group designs but expands this system to include single-subject (within-subjects designs), outcomes (i.e., evaluation), and qualitative designs. Level evidence requires well-controlled group experiments including random assignment with manipulation of an intervention. Designs that result in Level 2 evidence do not include randomization but are otherwise well-controlled experiments or comparison studies. Within this

system, controlled single-subject designs (e.g., alternating treatment; multiple baseline) are classified as providing Level 2 evidence because subjects are not randomly assigned to condition but are compared with themselves. Level 3 evidence includes comparison studies with one (or both) of the comparisons being retrospective. Level 4 evidence studies have no comparison groups or conditions. Level 5 includes all nonexperimental research (i.e., case study descriptions; qualitative studies) that suggest possible relationships between interventions and outcomes.

For our analysis, each article was read independently by two reviewers who determined study type and level of evidence. Results were compared and, in instances of disagreement, the reviewers discussed their ratings and came to a consensus about the study type or level of evidence to be assigned. Following ratings of study type and level of evidence, the 27 empirical articles were organized into categories based on primary content. Results were then summarized by content area.

RESULTS

The number of published articles in each 5-year time period from 1980 through 2004 is presented in Figure 1. The largest number of empirical articles about teaching practices were published more than 15 years ago. In the past 15 years, only 10 empirically based articles were published, and the numbers of these reports have decreased over time. On the other hand, the numbers of nonempirical reports about AT with infants and young children have increased over time; 22 articles were published in the past 5 years.

The group of 77 articles describe recommended practices in a variety of areas related to AT with infants and young children but do not provide experimental evidence about the effectiveness of AT with infants and toddlers. (A total of 21, or 27%, of these have been published by the same author.) General recommended practices for using AT with family-centered models (e.g., Judge, 2002; Parette, 1997; Parette & McMahan, 2002; Parette, VanBiervliet, & Hourcade, 2000) or within early intervention (e.g., Long et al., 2003; Parette, 1994; Sullivan & Lewis, 1993) are the focus of many of the nonempirical reports. Others target specific aspects of the AT process such as assessment (Hourcade, Parette, & Huer, 1997; Parette & Brotherson, 2004) or funding (Parette, Hoffmann, & VanBiervliet, 1994). Others describe AT intervention generally (e.g., Behrmann, Jones, & Wilds, 1989; Behrmann & Lahm, 1983; Brinker & Lewis, 1982; Sullivan & Lewis, 1993) or provide descriptive information about particular skills and the role of AT in promoting skill performance. For example, articles focus on the use of devices related to mobility
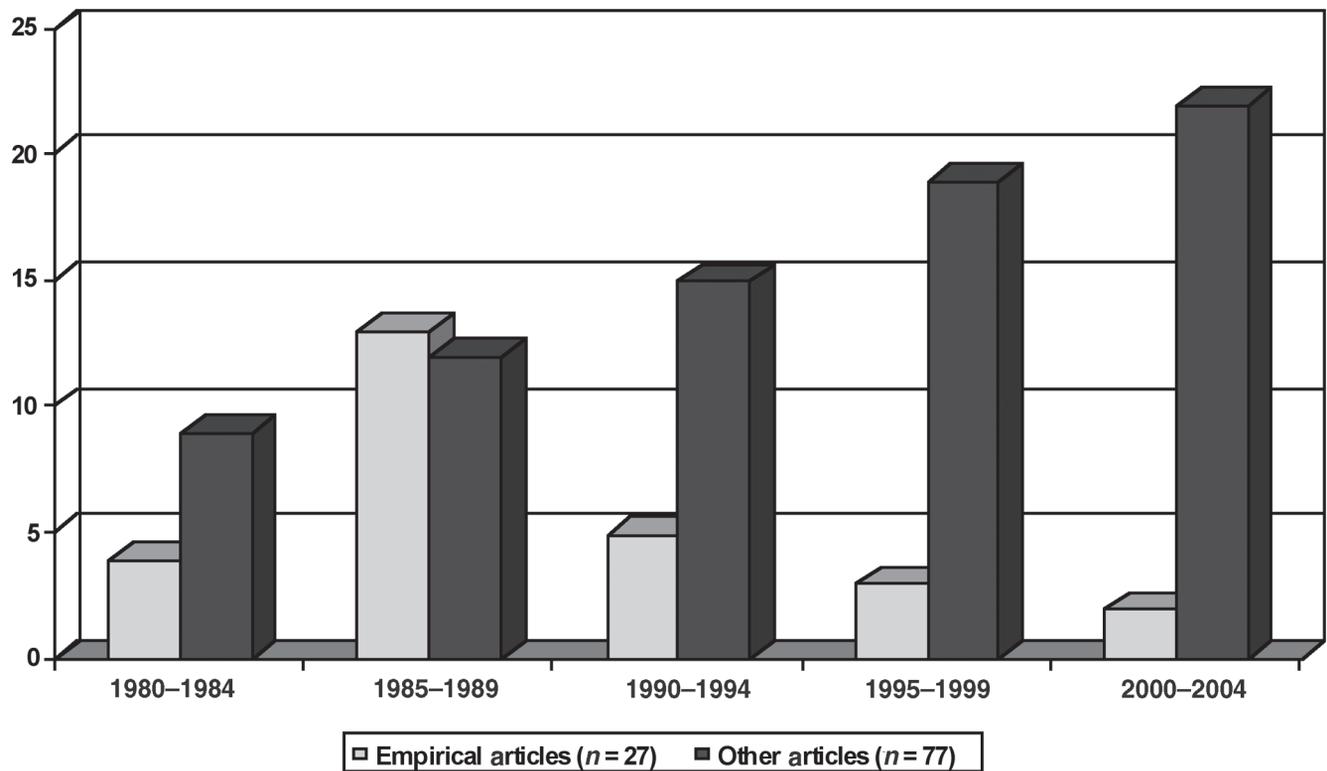
FIGURE 1. Number of articles about assistive technology (AT) with infants and young children published over the past 25 years.

(Butler, 1988), play (Lane & Mistrett, 1996, 2002), or AAC communication (e.g., Berry, 1987; Light & Drager, 2002; Light & Kent-Walsh, 2003; Parette & Angelo, 1996; Reinhartsen, Edmondson, & Crais, 1997). These articles provide information about AT practices and use with young children with disabilities but do not provide practitioners or families with specific intervention strategies that are effective in using AT as an intervention with young children.

The 27 empirical articles were grouped by content into five areas: switch interface device use (n = 12; 44%); computer use (n = 6; 22%); power mobility (n = 4; 15%); AAC communication (n = 1; 4%); and a group of articles reporting on experiments to teach use of prosthetic limbs (n = 4; 15%). Because prosthetic limbs are generally viewed more as medical devices than as AT, these four articles were not included in further analyses of teaching practices, which resulted in a total of 23 articles that reported strategies for teaching young children to use switches, computers, power mobility, or communication devices.

Only 1 of the 23 studies was classified as a well-controlled experiment using random subject assignment with manipulation of the intervention (Level 1). Ten studies (44%) were single-subject comparison designs without random assignment (Level 2). Eight studies (35%)

were group studies without randomization or comparison groups (Level 4). Four studies (17%) described individual cases or reported qualitative data (Level 5). Overall, a majority of the studies about AT teaching practices used single-subject designs where nonrandomized controls were provided through experimental manipulation, which resulted in a fairly robust level of evidence for all AT studies as a whole.

Switch Interface Device Use

Twelve studies (Behrmann & Lahm, 1983; Cook, Liu, & Hoseit, 1990; Daniels, Sparling, Reilly, & Humphry, 1995; Dunst, Cushing, & Vance, 1985; Ferrier, Fell, Mooraj, Delta, & Moscoe, 1996; Hanson & Hanline, 1985; Horn & Warren, 1987; Horn, Warren, & Reith, 1992; Light, 1993; Meehan, Mineo, & Lyon, 1985; Sullivan & Lewis, 1990, 2000) focused on teaching switch activation use to young children with disabilities in a variety of situations. A majority of the studies used single-subject designs (n = 6) or case study descriptions (n = 2); 4 were noncontrolled group research designs. Infants and young children in all 12 studies were described as having cerebral palsy, severe or multiple disabilities, severe motor delays, or Down syndrome. Only two studies included children without disabilities (Behr-

mann & Lahm, 1983; Cook et al., 1990). The ages of children ranged from 2.5 to 60 months; 7 studies (58%) were limited to children under the age of 36 months. Children were taught switch use in experimental (*n* = 8) and home (*n* = 4) settings.

Ten (83%) of the 12 switch activation studies were designed to teach contingent responding; 2 used switch activation for purposes other than contingent responding. Contingency training studies consisted of six single-subject, one case report, and three group designs. Various types of switches were activated with a response (e.g., head turn; head movement; leg movement; touch) that was already in the child's repertoire. The types of switch devices and the outcomes produced varied across these studies. Some switches were attached to toys, others to computer displays. Others prompted feedback from an adult, usually the mother. Across most studies, switch activation was measured as the primary dependent variable. Some studies measured additional outcomes such as child engagement or attention.

Switch activation resulted in outcomes or consequences. The expectation was that the rate or frequency of switch activation would increase if the resultant consequences (e.g., toy activation; recording of mother's voice; visual display; music; vibration) were, in fact, reinforcing to the child. Several studies maintained the same outcome across all training sessions for all children (e.g., Dunst et al., 1985; Ferrier et al., 1996), and others determined a preferred outcome for each child and maintained that outcome across all training sessions (e.g., Hanson & Hanline, 1985). More sophisticated delivery of outcomes was reflected in studies conducted with the use of microcomputers to mediate between the switch activation and delivery of outcomes. These employed both single-subject (e.g., Behrmann & Lahm, 1983; Horn & Warren, 1987; Horn et al., 1992) and group designs (Sullivan & Lewis, 1990, 2000). The use of microcomputer programming allowed for changes in outcomes both within and across training sessions and for the length of activation of the outcome to be controlled, theoretically capitalizing on infants' and young children's interest in novel situations and reducing the possibility that a particular outcome would become uninteresting and, therefore, no longer reinforcing for the child.

Manipulation of the outcome produced by the switch was the primary teaching strategy used to teach switch activation. In addition, children's continued use of the switch provided opportunities to practice the motor response, although in these studies, the motor response used to activate the switch was already in the repertoires of the children. Only one single-subject study reported teaching strategies when the desired response needed to activate the switch was not in the child's repertoire (Meehan et al., 1985). A four-phase approach of systematic prompting and prompt withdrawal techniques was used

to successfully teach activation of an adapted toy. In each phase, the child was presented with the switch. In Phase 1, if the switch was not activated, hand-over-hand physical guidance was used and accompanied by adult verbal praise. In Phase 2, the child's hand was placed on the switch without activation. A physical prompt consisting of a nudge or tap behind the child's elbow was used in Phase 3, which was reduced to only a verbal prompt in Phase 4.

Two additional studies taught switch activation in situations other than contingent responding. In a case study report, a strategy of altering stimulus complexity was used to teach use of an automatic linear scanning device via a four-step training process that required a child to select correct pictures by activating a lever switch mounted on the headrest of her wheelchair (Light, 1993). In the first training phase, the child was required to select a highlighted picture from three stimuli items, two of which were blank. In the next phases, she was required to select the correct (highlighted) picture from an array of three, then four, and finally five pictures. In the final phase, the highlighting cue was removed. Three typical children and six children with disabilities were taught to use a switch to control a specific tool (e.g., a robotic arm) for the purpose of obtaining a desired out-of-reach object using the arm (Cook et al., 1990). Two of the six children with motor disabilities and all of the typical children learned to use the arm to obtain out-of-reach objects. A three-condition training process was used. In the initial condition, the children were taught the use of the switch to activate a favored toy. The toy was removed and the switch was attached to a robotic arm. The children were then taught to retrieve items through single-touch switch activation. In the final training condition, the children were required to continuously activate the switch until the object had been fully retrieved.

As a whole, these 12 studies provide relatively strong evidence that children younger than a year old and with a variety of types of disabilities including cognitive disabilities may be successfully taught to operate switches to activate toys or provide other outcomes when switch activation uses an existing movement and results in outcomes that are reinforcing to the child. As many of the subjects in these studies had physical or multiple disabilities, it is probably not surprising that most of the studies used single-subject designs. Two group studies reported data for 160 infants under the age of 18 months, but subjects were neither randomly selected nor assigned to intervention conditions, and no control condition was used.

Computer Use

Six articles explored the use of computers with young children. Three used group designs (Lehrer, Harckham, Archer, & Pruzek, 1986; O'Connor & Schery, 1986;

Parette, Hourcade, & Heiple, 2000), two used single-subject methods (McCormick, 1987; Spiegel-McGill, Zippiroli, & Mistrett, 1989), and one was an observational/exploratory study (Fazio & Reith, 1986). Only two studies included children with physical disabilities, and a majority included children with mild mental retardation, speech and language impairments, or delayed development. Across all studies, the youngest subject was 22 months old. Most studies involved children between 36 and 60 months. All of the studies were conducted in preschool programs for children with disabilities.

These studies used computers for different purposes. One study compared traditional and computer instructional methods (Lehrer et al., 1986), one compared traditional language strategies with computer instruction (O'Connor & Schery, 1986), two studies measured the effects of computer use on children's social interaction (McCormick, 1987; Spiegel-McGill et al., 1989), and two studies investigated children's competence with computer use (Fazio & Reith, 1986; Parette, Hourcade, et al., 2000).

In a majority of the studies, the primary intervention was exposure to the computer either alone or with teacher or peer facilitation. Computer software provided programmed learning experiences in all studies. Three methods (Logo with robots, individualized drill and practice software, and standard control of teacher-directed activities) were compared, with children randomly assigned to each of the conditions to measure effects on children's problem-solving, language, and cognitive development (Lehrer et al., 1986). Children in the Logo with robots method displayed higher levels of problem-solving and linguistic abilities when compared with the teacher-directed activity control group. Children using individualized software improved in the skills taught via the computer. In a group comparison of a teacher-directed software-based programmed learning experience and traditional language interactions between a teacher and child, children learned more vocabulary through the computer-delivered instruction method (O'Connor & Schery, 1986).

The use of computers as social facilitators was the focus in two similar studies with somewhat different results. Both studies compared the effects of computer and toy play activities on communicative interactions between children with and without disabilities. In the first study, social interactions were greater when children were using the computer than when they were playing with toys (McCormick, 1987). Children with disabilities were paired with typical children in dyads and exposed to three different play situations. For children with mild disabilities, interactions with typical peers were equal in all play situations, but for those with severe disabilities, interactions with a peer were greater in the computer play situation (Spiegel-McGill et al., 1989).

Children's patterns of computer use (time spent, amount of teacher assistance required, and software selection) were measured over a 5-week time period during which a computer was made available during free time. On average, children selected the computer 75% of the time and required a decreasing amount of adult assistance over the length of the study. They infrequently chose either drill-and-practice software or software requiring complex motor or conceptual responses; instead, they preferred software that included bright colors, sound, and animation. In a study designed to improve computer literacy skills (e.g., keyboarding), children received a teacher-conducted 1-hr training session twice a week using the Keyboard Kids Curriculum (Parette, Hourcade, et al., 2000). Improvements in computer skills were demonstrated by all children.

Despite the possibilities in computer use by young children, only six studies in our review addressed this topic, and these targeted different outcomes. With the exception of the Lehrer et al. (1986) study, which compared the effects of two types of computer activities (e.g., drill and practice; Logo problem solving) with a standard practice control condition of teacher-directed activities, none of the studies used either random assignment or control conditions. Two studies used single-subject designs with within-subject controls, but the remaining three studies resulted in evidence at the lowest levels (e.g., Levels 4 and 5). Each study explored a different purpose (or use) for computers with young children, which made comparisons of interventions difficult. Both the small number of studies conducted in this area and their designs result in a small body of inconclusive evidence about the effectiveness of strategies or interventions for enabling computer use by infants and young children.

Power Mobility

Four articles reported strategies used to teach young children to use power mobility devices (Butler, 1986; Butler, Okamato, & McKay, 1983, 1984; Zazula & Foulds, 1983). Two group studies (Butler et al., 1983, 1984) taught young children to operate a power mobility device. A third study examined design, selection, and teaching strategies to promote the use of a small, motorized cart for an 11-month-old child with no limbs (Zazula & Foulds, 1983). In a single-subject, multiple baseline design, six children between the ages of 23 and 38 months, described as having average cognitive abilities but severe physical disabilities, were taught to operate a power mobility device (Butler, 1986), and the effects of power mobility on children's self-initiated behavior and interactions with people and objects were measured.

In the three studies of acquisition of power mobility skills, children were taught at home by their parents,

who used a strategy of opportunity and practice. In the two studies conducted by Butler and her colleagues, parents were instructed to have children spend several hours per day seated in the chairs. In both studies, nearly all of the children became independently mobile within 3 weeks. Children were considered competent with regard to their driving when they mastered the following seven skills: stopping, starting, driving straight in open areas, driving straight in narrow corridors, turning around, turning corners, and coming in close proximity to people and furniture. Similar strategies were described in a case study report about teaching power mobility to an infant without limbs (Zazula & Foulds, 1983). The report described the procedures used to design and fit the device, a powered cart operated by a foot switch. An initial one-time training session for the child and parents took place in a clinic. During this session, experiences with moving the device with the child sitting on the floor using a remote switch were provided to familiarize the child with the cart. The parents were then shown how to use the remote switch to move the device with the child riding as a passenger. Then, the foot switch was made active with the child riding in the cart. In 4 months of opportunity to move the device at home, the child was able to move forward safely. Following 6 months of use, the child was competent in all functions using the cart.

The influence of power mobility on children's use of self-initiated behaviors was examined in the final study of mobility (Butler, 1986). Six children were videotaped for 2-hr sessions in their homes before and after they achieved power mobility. Frequencies of self-initiated interaction with objects, spatial exploration, and communication with their caregivers were measured. Half the children showed increases in the frequencies of all targeted behaviors; the others increased in some but not all three measures.

Allowing children in these studies access to a power mobility device and providing opportunities for them to practice using the device resulted in competent use by children with physical disabilities and typical cognitive abilities. However, the level of evidence for successful outcome is relatively weak, as two of the three studies compared pre- and posttest measures on children who received the power mobility device and one study described the use of a mobility device with one child.

Augmentative and Alternative Communication Devices

Only 1 of the 23 studies reported on the effectiveness of teaching young children to use AAC devices (Schepis, Reid, Behrmann, & Sutton, 1998). A single-subject design was used to teach four children with autism to use a voice output communication aid (VOCA) during snack and play routines in their classrooms. Cheap Talk was se-

lected as the device to be used by all children based on children's performance during an ongoing assessment period. Children were trained to use the device through a naturalistic instructional strategy from teachers. Teachers were trained in use of the strategy through a 30- to 45-min training session. The sessions focused on one target child and the classroom routine selected for intervention. The primary components of the naturalistic instructional strategy involved using child-preferred stimuli available within the natural routine, using child-initiated responses as the point of intervention, and providing verbal and gestural prompts with minimal use of physical guidance. The experimenter modeled natural cues such as expectant delay, questioning looks with eye contact, and physical approach techniques. Following the instructional sessions, the target children were given their VOCA devices during one of the specific classroom routines. Classroom staff began to model the use of the VOCAs for the children by pressing keys and directing attention to the graphic symbols. The children were then given 1 min to freely explore their VOCAs. The children's subsequent sessions with the VOCAs included no further instruction from staff. Children were observed for their use of child-to-child communication, physically guided VOCA use word vocalization, nonword vocalization, and gesture. Observations also focused on the classroom staff members' communicative interactions with the children as well as any specific verbal prompts to communicate. Results of the analyses indicated that all children demonstrated an increase in communicative interactions during the VOCA and naturalistic teaching condition when compared with baseline measures.

DISCUSSION

Over the past 25 years, an increasing number of articles about AT with infants and young children have been published. However, only 38 articles published during this time period reported data, and of these, 23 were classified as empirical reports about teaching children to use devices. As a whole, evidence of effectiveness of AT device use by infants and toddlers is limited in terms of the number of published reports, the content areas emphasized, and the level of evidence provided.

Although the types and availability of AT devices have increased dramatically, more than half of the articles described strategies to teach activation of switch interface devices. This emphasis on switch activation may relate to the fact that most articles were published more than 15 years ago. In addition, the children who were taught to use AT devices had various types and combinations of low-incidence physical or sensory disabilities, which may have reflected a traditional viewpoint about when and with whom AT devices are appropriate. Therefore, it is

not surprising that the empirical literature includes few group studies or that published studies have relied on single-subject designs. When single-subject designs include within-subject comparisons, reasonable evidence levels (i.e., Level 2) for testing the effects of well-defined intervention practices are provided, for example, in situations in which identifying like subjects in sufficient numbers for group study may not be feasible (Butler et al., 1999).

The primary teaching practice reported across studies involved access to the device (e.g., switch, computer, power chair) and the opportunity to practice its use. In the switch activation studies, a switch that could be motorically activated by the child was tied to an outcome so that switch activation resulted in movement of a toy or interaction with an adult that was believed to be reinforcing for the child. In the computer use studies, an opportunity to use the computer, either alone or in combination with teacher or peer facilitation, resulted in children's learning skills taught by the computer software as well as their increasing social and communicative interactions with other children. Children learned power mobility simply through the opportunity to "experiment" with moving the power mobility device and were able to maneuver the device within about a 3-week time period, and they fully demonstrated "driving" competencies within 4 to 6 months of practice. Only three studies described other teaching strategies, and two were descriptive case study reports (Level 5) about using a switch-operated scanning device and activating a switch using a motor response that also had to be taught (i.e., it was not already present in the child's repertoire). In the third study, a well-controlled single-subject design (Level 2), naturalistic teaching strategies were used to teach use of a voice output communication device.

Until recently, the use of AT devices with infants and young children with low-incidence disabilities has been advocated primarily as a way to improve children's functional skill performance in areas such as mobility, communication, or play. Only recently has AT-enhanced performance been viewed as a means for infants and young children to participate in everyday activities and routines by using skills effectively within these contexts (Campbell, Milbourne, & Wilcox, in press; Mistrett, 2001, 2004). These 23 articles reported effective teaching strategies for improving targeted skills. The limited emphasis on the context (e.g., everyday activities and routines) in which the skills would be used perhaps reflects the time period during which a majority of these articles were published or a continued emphasis on AT as a means of enabling performance of functional skills regardless of the context in which these skills are to be used. All studies in the computer category taught computer use as part of preschool classroom activities. In many instances, these were self-contained special educa-

tion preschool classrooms. Children were given opportunities to learn switch activation and power mobility skills in their homes, although the training provided was not always incorporated into typical family activities and routines but rather was provided as separate training sessions that parents carried out at home. Only 1 of the 23 studies actually taught children functional skill use within the context of typical activities and routines. In this study, children were taught to use voice output communication aids within the context of routines taking place in their special education preschool classrooms.

Recommended practices for infants and young children with disabilities address concepts of natural environments and inclusion (e.g., Mistrett, 2004; Stremel, 2005). Both concepts emphasize successful participation in the activities and routines in typical settings such as homes, childcare programs, or schools. AT devices, when successfully used, may enable children with even the most severe disabilities to participate in these activities and routines. Yet, the literature reports little empirical data to provide practitioners or families with strategies for how to teach children successful use of the wide range of currently available devices. Clearly, research to identify effective teaching practices for infants and young children with disabilities should test strategies with a wide range of devices, across different types of disabilities, and across a variety of settings and should use both well-controlled single-subject and randomized group designs.

The existing database of effective teaching practices can provide early intervention and preschool providers with information about how to successfully teach children switch activation and powered mobility, but the studies conducted using computers and the one study on teaching the use of an AAC device do not provide a sufficient range of information to be helpful. These limitations in the current body of knowledge about AT interventions define a needed research agenda. Although this agenda may likely be primarily implemented through well-controlled single-subject studies, there are possibilities for various types of group intervention studies of children who have less severe developmental delays or when interventions with low-technology devices are being implemented. Future studies should align with current recommended practices and test intervention effectiveness not just for performance or improvement of isolated skills but for promoting children's successful participation within a variety of everyday activities and routines. ◆

AUTHORS' NOTES

2. The initial research for this review was completed by Melissa Moreno, a master's student at the Thomas Jefferson University, Jefferson College of Health Professions, Department of Occupational Therapy and research assistant with Child and Family Studies Research Programs.
3. Additional detailed information about these analyses may be found at http://tnt.asu.edu.

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(Continues with Appendix)

APPENDIX

Author	Year	Type of design	Level of evidence	Sample size	Participant age in months	Participant characteristics
Switch Interface Studies (*n* = 12)						
Behrmann & Lahm	1983	Group (3-phase treatment repeated across subjects; no control group)	4	15	11–27	Mild, moderate disabilities including severe motor and sensory disabilities (*n* = 10); typical (*n* = 5)
Cook, Liu, & Hoseit	1990	Group (2-phase treatment repeated across subjects; no control group)	4	9	> 38	Developmental delay (*n* = 6); typical (*n* = 3)
Daniels, Sparling, Reilly, & Humphry	1995	Single Subject (alternating treatment)	2	2	24; 40	Lack of head and trunk control; spastic quadriplegia with moderate mental retardation
Dunst, Cushing, & Vance	1985	Single Subject (ABA)	2	6	< 36	Profound retardation; multiple disabilities
Ferrier, Fell, Mooraj, Delta, & Moscoe	1996	Descriptive Case Report	5	1	5	Club feet, hydrocephaly, poor muscle tone
Hanson & Hanline	1985	Single Subject (ABA)	2	3	8–25	Spastic quadriplegia, Down syndrome, & cerebral palsy with seizure disorder
Horn & Warren	1987	Single Subject (multiple probe with replication with 2nd subject)	2	2	17; 24	Severe motoric delays
Horn, Warren, & Reith	1992	Single Subject (ABAB multitreatment)	2	6	16–60	Cerebral palsy
Light	1993	Case Study Report	5	1	60	Cerebral palsy with severe quadriplegia
Meehan, Mineo, & Lyon	1985	Single Subject (alternating treatment)	2	1	60	Severe spastic quadriplegia
Sullivan & Lewis	1990	Group Research; pre- posttest with no control or random assignment	4	40	2.5–15.5	Physical and mental handicaps due to cerebral palsy, Down syndrome, prematurity with neurological insult
Sullivan & Lewis	2000	Group; pre- posttest with no control or random assignment	4	120	< 18	Down syndrome (*n* = 60); cerebral palsy (*n* = 40); other (*n* = 40)
Computer Studies (*n* = 6)						
Fazio & Reith	1986	Observational Study	5	20	36–60	Mild mental retardation, behavior disorders, language impairments (no physical disabilities)
Lehrer, Harckham, Archer, & Pruzek	1986	Group; random assignment to one of 3 groups; 2 intervention conditions; 1 control	1	120	30–54	Speech and language impairments
McCormick	1987	Single Subject (multiple baseline)	2	5	36–72	Social and language delays
O'Connor & Schery	1986	Group; repeated measures; two intervention conditions repeated for all subjects	2	8	22–35	Down syndrome (*n* = 6); developmental delay; severe emotional disorder

(Appendix continues)

(Appendix, continued)

Author	Year	Type of design	Level of evidence	Sample size	Participant age in months	Participant characteristics
Parette, Hourcade, & Heiple	2000	Group: pre-post with no random assignment or control group	4	33	36–60	Cerebral palsy, autism, developmental delay
Spiegel-McGill, Zippiroli, & Mistrett	1989	Single Subject (alternating treatment)	2	8	56–64	Orthopedic impairment (*n* = 4); typical (*n* = 4)
Mobility Studies (*n* = 4)						
Butler	1986	Single Subject (multiple baseline)	2	6	23–38	Myelomeningocele; spastic quadriplegia CP, congenital malformation of the limbs, & other orthopedic disabilities
Butler, Okamato, & McKay	1983	Group: pre-post with one treatment and no control group	4	9	20–39	CP & other orthopedic disabilities
Butler, Okamato, & McKay	1984	Group: pre-post with one treatment and no control group	4	13	20–37	CP & other orthopedic disabilities
Zazula & Foulds	1983	Descriptive Case Report	5	1	11	Multiple limb deficiencies (no limbs)
Communication (*n* = 1)						
Schepis, Reid, Behrmann, & Sutton	1998	Single Subject (multiple baseline)	2	4	36–60	Autism