DOCUMENT RESUME

ED 281 333 EC 192 430

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TITLE Cognitive and Communicative Development in Severely Physically Handicapped Non-Speaking Children.
PUB DATE Sep 86
NOTE 28p.; Paper presented at the International Conference on Augmentative and Alternative Communication (4th, Cardiff, Wales, September 22-24, 1986.)
PUB TYPE Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Case Studies; *Cerebral Palsy; *Cognitive Development; Communication (Thought Transfer); *Computer Oriented Programs; Computers; Courseware; Educational Strategies; Elementary Education; Expressive Language; Input Output Devices; *Language Acquisition; Peer Teaching; *Perceptual Motor Learning; *Physical Disabilities; Receptive Language; Sensory Integration
IDENTIFIERS Augmentative Communication Systems

ABSTRACT

The paper discusses the use of computer technology with severely physically disabled children to facilitate sensory-motor development and enable acquisition of the cognitive prerequisites for augmentative communication. Following a discussion of theoretical perspectives on communicative and cognitive development, the characteristics of children selected for training are described, specific objectives of motor training enumerated, and observed motor responses defined. Elements of training are discussed within the framework of the following goals: (1) train child to activate a single switch voluntarily and reliably; (2) facilitate perceptual motor development in order to train the child to use the newly acquired motor response to respond to sensory input; (3) facilitate receptive language development; (4) facilitate expressive language development; and (5) develop a communication system using a visually directed scanning approach. Related suggestions for classroom implementation include a nondistracting environment, individual instruction, and social integration with nonhandicapped peers through the use of peer tutors. Application of this training approach with a 9-year-old boy with severe cerebral palsy is described. (JW)

Cognitive and Communicative Development In Severely Physically Handicapped Non-Speaking Children

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A lecture presented at the Fourth International Conference for the International Society for Augmentative and Alternative Communication, St. David's Conference Centre, Cardiff, Wales, United Kingdom, September 22-24, 1986. This manuscript is in preparation for submission to Augmentative and Alternative Communication.

Cognitive and Communicative Development In Severely Physically Handicapped Non-Speaking Children

One of the most problematic issues in the field of augmentative communication is how to meet the communication needs of the severely physically handicapped child who has not yet developed a reliable means of response. There is a wide spectrum of communication aids to meet varying levels of ability. However, the use of any communication device requires certain cognitive, linguistic, communicative, psycho-social, and motoric prerequisites (Owens & House, 1984; Shane & Bashir, 1980). If a child does not possess these prerequisites, a traditional training program is initiated to teach the child the skills which would then make him/her eligible for a communication system.

Little guidance has been provided to professionals with respect to how to train prerequisites for communication system use. We exclude the severely physically handicapped from augmentative communication intervention until they demonstrate skills which would enable us to fit them with an appropriate aid. However, it is these early stages of development that are the most crucial and require intensive intervention (Buzolich, in press). The computer is a powerful and versatile tool for developing sensory-motor skills which would enable these children to access a communication system. The present paper will present a theoretical position on early cognitive and communicative development in severely physically handicapped, non-speaking children. A high-tech program for training pre-requisite skills will be presented. A case study will be reported of a child who has been treated

Abstract

There is a growing number of severely physically handicapped children with no viable means of communication. They are often described as having no voluntary motor response but are able to "communicate" with primary caregivers through nonverbal and vocal behavior. These communicative behaviors are considered to be at a pre-intentional level. The present paper discusses how technology can be applied to this population to facilitate sensory-motor development and enable these youngsters to acquire the necessary cognitive prerequisites for augmentative communication. The intervention program is based on a multi-disciplinary theoretical model which takes the position that these children exhibit disordered rather than delayed development. The intervention program utilizes strengths to compensate for weaknesses in an attempt to develop a system of communication for each child. This paper will report on a case study of a child who has been followed for 3 years on this program and will discuss research in progress.

for the past 3 years using the the microcomputer as the primary training tool.

Theoretical Position

There are many reasons why a child may be unable to talk. They may have a neurological disability which interferes with their ability to produce intelligible speech, or use language. They may also have some physical, emotional, or cognitive disability (Asha, 1980) which interferes with their ability to speak. In order to determine if a non-speaking child is a candidate for an augmentative communication system, there are numerous cognitive, communicative, and linguistic factors to consider (Chapman & Miller, 1980; Owens & House, 1984; Shane & Bashir, 1980). It is the child who exhibits a disproportionate gap between what he understands and what he is able to intelligibly communicate who is appropriate for augmentative communication. (Chapman & Miller, 1980). This criterion, however, depends on a childs ability to demonstrate his understanding of language. Many researchers and clinicians have said that a child must demonstrate the sensori-motor prerequisites for intentional communication (Piaget Sensorimotor Stage 5) before an augmentative communication system can be introduced (Chapman & Miller, 1980; Owens & Hourse, 1984; Shane & Bashir, 1980). For a severely physically handicapped child, the development of sensori-motor skills may be limited by (1) lack of a volitional, reliable motor response (2) lack of motor control for eye gaze and (3) visual/auditory acuity and/or perceptual disorders (Fried-Oken, & Terry, 1985). This same child may however, demonstrate some rudimentary understanding of language and communicative intent. With the present criterion this child would be excluded from service due to his/her severe physical limitations.

The present criteria for determining eligibility for augmentative communication is based on normal developmental models. We must abandon our previous conceived notions of equating physical disability with mental retardation. Children with congenital motor and sensory handicaps medically diagnosed with cerebral palsy are children with congenital neurological deficits. Severely physically handicapped children are unique with respect to the nature and extent of their neurological deficits and how it effects their ability to learn. They exhibit individual patterns of strengths and weaknesses. Although they are often delayed in the acquisition of skills relative to their chronological age, it is more appropriate to view their pattern of development as disordered relative to their neurological deficits. An appropriate program for cogntive and communicative development for the severely physically handcapped child is based on identifying and utilizing the child's strengths to compensate for his/her weaknesses.

For the severely physically handicapped child cognitive development is affected by a damaged brain. The literature suggests that form (the integrity and structure of the brain itself) and function (physical behavior or use) are intimately related. The normal developing infant is a participant in his/her development. The ability to respond and act on the environment stimulates and accelerates development. For the severely physically handicapped child, this is not possible. Consequently, development is further delayed as a function of the child's inability to take an active role in his/her own development. In order to compensate for the handicapped child's physical limitations, we need to provide a means with which he/she can interact with the world around him/her so that we create an open system. Technology is a tool which enables us to compensate for physical deficits and provide a means for interactive learning, to influence cognitive development and achieve the maximum functional potential.

<u>Program for Early Cognitive and Communicative Development</u>

The program described below is the result of 3 years of exploratory clinical research. At this time only one child has successfully completed the prgram and is presently using a communication system. There are currently 3 children on the program with plans for several more to begin in the coming year. Data is being collected on each child which includes videotaped samples of therapy sessions collected quarterly. The results of the research in progress will be presented in a subsequent paper at the completion of the study.

<u>Criterion for Subject Selection</u>

The program has been applied only to children with a primary medical diagnosis of severe spastic quadriplegia (cerebral palsy) of congenital origin. This is not to say that the program would not be applicable to other handicapping conditions, but rather that the effectiveness has only been tested on children with spastic cerebral palsy. Below is a description of the multiple handicaps typical of children appropriate for this program.

(a) Non-verbal (without functional speech)

(b) Distractibility

(c) Short attention span

(d) Fluctuating levels of alertness

(e) Delayed response time (greater or equal to 10 seconds)

(f) Visual field defects

(g) Inability to sustain fixation on objects

(h) Inability to visually track objects or people

(i) Perceptual/motor deficits (e.g. inability to visually or auditorally attend to a stimulus and perform a a motor response simultaneously).

(j) Immature visual perceptual development (e.g. inability to match objects, colors, shapes, object to picture matching).

(k) Lack of voluntary motor response

(l) Limited and variable voluntary motor response

(m) Lack of control of voluntary motor response

(n) Behavioral problems, e.g. non-compliance, low motivation, excessive laughing and crying

Children who can be described in this way are often given a passive role of "receiver" in the educational setting. They are physically present in school but due to the severity of their motor handicaps, they are not expected to respond in other than an affectual way. They are unable to participate in the learning process. Consequently, they are unable to learn.

Program Description

The program described below utilizes the computer as its primary educational tool. The benefit of using a computer with a young severely handicapped child is that you have a versatile tool that will develop with the child. Once the child has achieved enough essential skills to operate a communication system independently, he can be fitted for a portable communication system with features and capabilities like that of the microcomputer based communication system. This program is hierrarchical in that each new skill builds on a previously acquired skill. It does not, however, preclude proceeding with higher level tasks, so long as the trainer provides the necessary prompts to enable the child to be successful.

Motor Training

Prior to implementing a motor training program a positioning and control evaluation should be conducted in order to insure that the child is appropriately positioned in his/her wheelchair so that optimum control can be achieved. There may already be one body site which yields a reliable response. It is more likely however that a body site will be identified which yields both voluntary and involuntary motor responses. It is best to choose a body site in which both movements are performed easily and quickly. It is important to keep in mind that it is easier to shape an involuntary response into a voluntary response than it is to chose a body site in which motor responses of any kind are infrequent. Begin with one body site and one switch, appropriately positioned for easy access. Below are suggested goals and objectives for a child who has not yet acquired reliable, voluntary motor control.

Goal 1: Train child to voluntarily and reliably activate a single switch.

Objective 1: Child will activate switch when provided with auditory and visual cues from trainer.

Objective 2: Child will activate switch to operate cause-effect software on the microcomputer.

Objective 3: Child will activate and release the switch to advance one frame/hit on auditory/visual directed scanning software programs.

Objective 4: Child will voluntarily and reliably activate switch to operate battery operated or electrical toys.

Objective 5: Child will operate 3 electrical appliances of his/her choice for environmental control within the home setting.

Objective 6: Child will activate a call signal when directed to do so.

Objective 7: Child will activate a call signal to call attention to self, when appropriate.

Motor training should ocur independent of cognitive or linguistic demands. The switch can be connected to toys and software programs on the computer but no demands should be placed on the child to attend to what he/she is seeing or hearing in response to hitting the switch. Motor training tasks should be set up in a reinforcing way so that the child gets some payoff for cooperation. For example, a specified number of consecutive "hits" can be followed by some highly reinforcing activity or reward.

In order to track progress and determine if the child is responding to the treatment program, the trainer should record and analyze all responding behavior during the training sessions. Each response the child emits is assigned a qualitative score. Below are definitions for each of the categories.

Definitions of Motor Responses.

Hits (H): Child hits the switch when directed to do so and activates the toy, software program, call signal, etc., within a designated period of time not exceeding 10 seconds.

Attempts (AT): Child touches switch with body site and makes an attempt but is not successful in activating the toy, program, call signal, etc. due to insufficient force, missing the target, etc.

Inadvertent Hit (IH): Child hits switch and activates toy, software, call signal, but not at an appropriate time. For example, child hits switch before directive is given by trainer or produces multiple hits in succession randomly and non-purposefully.

No Response (NR): Child does not respond to directive to "hit the switch" within designated period of time (10 seconds). No attempt to hit the switch is made. This may be behavioral, or due to attentional deficits, or simply the child's difficulty in voluntary motor movement.

The data on responding behavior is used as an indicator for modifying the program in some way. For example, if a child was not able to exceed 65% in achieving hits and the performance profile flattened out for several weeks, an alternative body site should be tryed to determine if motor learning would be facilitated using a different site or switch. This provides you with an opportunity to manipulate each relevant variable and individualize the program to suit the child's needs and abilities. As the child improves, the number of "no responses" decrease and the number of "attempts" and "inadvertent hits" increase. With greater control, the number of "hits" increase and the number of "inadvertent hits" and "attempts" decrease.

Perceptual-Motor Training

The purpose of perceptual-motor training is to train the child to utilize the newly acquired motor response to respond to sensory input. On the basis of a cognitive assessment, the clinician or educator may have some hypothesis regarding the child's optimal sensory input modality. Nevertheless, perceptual-motor training should proceed without bias to one input modality. As the perceptual-motor training progresses, the optimum modality will present itself. It may also be apparant that the child responds best to multiple sensory input. At this stage of training we are not concerned with whether the child understands the meaning of the auditory or visual stimulus, but rather that they learn to physically respond following the presentation of that stimulus. This phase of training will facilitate control in that the child will learn to respond frequently and quickly.

These skills are crucial prerequisites for operating a communication system. The majority of single switch communication systems available require visual and auditory scanning capability. Childrern with limited experience using single switches have a great deal of difficulty learning automatic scanning and there are few software programs available with directed scanning options. Below are some suggested goals and objectives for training these necessary perceptual-motor skills.

<u>Goal 2</u>: To facilitate perceptual motor development

<u>Objective 1</u>: Child will be able to hit a switch when directed to auditorally and/or visually by the computer within 10 seconds for simple cause/effect software programs.

<u>Objective 2</u>: Child will be able to perform stepwise (directed) auditory and/or visual scanning tasks using software programs on the microcomputer.

There are several software programs which can be used to implement objective #1. These include: Motor Training Games, Early Learning I, and Target. The child is trained to interact with the software program. When an auditory or visual stimulus is presented the child is required to hit the switch. The trainer must provide alot of prompts and demonstration initially and then slowly fade the prompts as the child's success increases, so that the child is responding to the computer rather than the trainer. Throughout the child's interaction with the computer there is a simultaneous interactive exchange between the trainer and child. The child selects some reinforcing activity such as building objects with Legos or earning tokens or stickers. The child needs these highly reinforcing activities to motivate him/her to perform the task. We are asking the child to do something that is difficult for him/her and therefore we need to make it worthwhile. Also because there is a need for alot of repetition to acquire these skills the reiforcing activities within the training sessions themselves need to be varied and individualized. While the program itself is very specific, the actual training sessions require a great deal of creativity in order to keep the child motivated and participating.

When training a child on directed visual scanning, begin with a forced-choice format in which the computer monitor is divided into two halves. Place a desired object on one half of the monitor and ask the child to move the light to the object using the switch. Decide on a confirmation response which will enable the trainer to know that the child has made his/her choice. This could include the use of another switch or some non-verbal behavior the child is easily able to produce. Systematically increase the number of frames as the child demonstrates success. Set a maximum number of frames which the child can reasonably handle. Then, sytematically increase the number of object stimuli displayed on the monitor. (It is also useful to have clear plastic overlay grids with pockets so that objects and pictures can be easily placed on the monitor). Rather than asking the child to identify the objects, you may present the same object to the child and ask him/her to put the light on the one just like it. You may also try object to picture and picture to picture matching tasks. In the language training program it would be most appropriate to ask the child to identify the objects, but only after the child has demonstrated that he/she has the necessary perceptual motor skills which would enable them to move the scanning light to any desired frame.

Language Training

Receptive language skills can be facilitated using single switch language software programs such as First Words (I and II), and First Verbs. These programs, however, utilize automatic scanning lines which are inappropriate for this population. The manufacturers failed to take into account the perceptual limitations of severely physically handicapped children at the early stages of language development. Consequently, much of the language therapy involves the use of directed auditory/visual scanning programs which require that you put your own graphics on the monitor using overlays.

Goals and objectives for language training are determined on the basis of the language assessment conducted in the non-oral communication evaluation. If the child has not yet demonstrated comprehension of language at the single word level using traditional techniques, you can build on the child's newly acquired motor and perceptual motor skills to demonstrate comprehension of common objects, actions, and agents using the computer. Expressive language skills could be facilitated using the computer with a voice-activated, light-activated communication board program such as Target with Speech. The number of frames displayed on the monitor would be chosen on the basis of the child's perceptual-motor capabilties so that the child could easily access any desired frame. The child would be able to activate a switch and scan choices either auditorally, visually, or both and stop the light when he makes a choice. A number of different language acitivities could be set up which provide a means to obtain an independent, unambiguous response. As the child is successful, provide more challenging language tasks. Some of these language activities are extremely motivating and enjoyable even if the child does not yet have the motor control. The trainer must keep in mind what the child's motor accessing skills are and provide additional cues and prompts to enable the child to perform the task semi-independently. It's helpful to show the child what he/she will be able to do once they achieve greater control with their switch. The more diversity you offer them, the more interested and motivated they will be. Below are some suggested goals and objectives for early language development using the computer as the primary tool.

Goal 3: To facilitate receptive language development

Objective 1: Child will be able to identify common objects, categories, and verbs using directed scanning language software with voice-output.

Goal 4: To facilitate expressive language development

Objective 1: Child will be able to name common objects, actions, and agents using a directed voice-output scanning software program.

On the basis of perceptual-motor training it will be apparant at this stage what sensory input modality (modalities) the child favors. All language training will utilize the optimal modality for sensory input for each child. A child who will require auditory scanning alone, may not even need to be oriented toward the computer during the training sessions, but rather toward the partner he/she is interacting with. Remember to carefully monitor linguistic complexity and to keep language activities context-specific to begin with. Systematically increase linguistic complexity to determine at what point the child is challenged. Keep all other variables such as motor accessing, and perceptual-motor limitations constant during language training.

Communication Training

As mentioned previously, children who will have to use a scanning rather than a direct select communication system will need to develop the prerequisite skills to operate either an auditory and/or visual scanning communication system. In addition the training program should provide the severely handicapped child with transitional low or high tech communication systems that will provide them with greater control. Despite the limitations of the transitional system, the child needs experience using direct communication acts because the transition from a nonverbal communicator to a system user is a gradual one (Buzolich, in press). The child should be provided with a communication system within his present functioning level. This communication system should meet his present needs while facilitating further development. Each subsequent system will build on the preceding one. These children will be in a constant state of transition and their communication systems will evolve as they develop. Below are an example of some early communicative goals and objectives for children who will need auditory scanning or visual scanning systems. Objectives for auditory scanning were taken from Fried-Oken & Kowalski, 1985).

Goal 5: To develop a communication system using an auditory scanning approach.

Objective 1: The child will use a single switch to make choices from live voice presentation.

Objective 2: The child will use a single switch to make choices from taped recordings of live voice presentation.

Objective 3: The child will use a single switch to make choices from taped synthetic voice presentation.

Objective 4: The child will use a single switch to make category choices and then item choices from taped synthetic voice presentations.

Objective 5: The child will be able to use a single switch to operate an auditory scanning software program for the purposes of communicating needs and wants.

Goal 6: To develop communication system using a visual directed scanning approach.

Objective 1: The child will use a single switch to make choices on communication mini-boards displayed on the monitor.

Objective 2: The child will be able to select a picture representing a context or topic specific mini-board.

At this early stage of development our primary concern is to engage the child in interactions in which he/she is contributing. Throughout the training sessions, the trainer should ask the child to make choices, using either an auditory scanning approach with live voice, or placing representative stimuli on the monitor and requiring that the child move the scanning light to a desired stimulus. While it is obvious that forced-choice responses are limiting and do not allow the child to initiate or elaborate, the children targeted for this program are early communicators who do not have the forms for more elaborate communication. There is much that can be taught during these early stages regarding interaction management, e.g. turn-taking, feedback to speaker, maximizing use of nonverbal communicative behaviors, etc. These children are so often treated as non-participants that they will display inappropriate behaviors during interaction, e.g. tuning out, non-responsiveness, inappropriate laughing, and crying. These children need a consistent level of interaction. The trainer should provide feedback to them regarding their interactive behavior and substitute indirect with direct comunicative acts. As they become more competent, appropriate communicative behaviors will replace inappropriate ones.

Psychosocial Factors in Training

These children require a highly reinforcing structured behavioral based program. They need to be provided with as much control over the actions in their environment as is reasonable. The more control they have, the less likely they will act out or fail to comply. Additionally, because these children have such severe handicapping conditions, they require one-to-one for all aspects of this training program. Until they are capable of independent communication they will remain dependent communicators; children who are unable to interact effectively without the assistance of technology and a trainer.

Program Needs

The program described above is intended to be implemented in both the home and school setting. This program is intensive, aimed at developing motor skills, a communication system, and access to technology (computer) which will remain a primary educational tool for the severely physically handicapped child. Below are some of the program guidelines:

(1) Instruction should be provided in a non-distracting environment.

(2) Computer-assisted instruction should be provided on an individual basis (one to one) for all academic instruction and therapy.

(3) The program should be an interdisciplinary effort between the

parents, classroom teacher, speech/language pathologist, and an occupational therapist or physical therapist familiar with motor training.

(4) Integration in the form of peer tutors is recommended to provide the handicapped child with opportunities to interact with non-handicapped peers.

Case Study: Peter

The program described above evolved as a result of several years of work with Peter. Below is a summary of Peter's development over the past 3 years.

Background and Pertinent History

Peter is a 9 year old non-verbal boy with severe spastic cerebral palsy. He lives at home with his parents and younger sister. He was initially evaluated at 6-years 8-months, shortly after his parents settled a medical mal-practice case for Peter. The parents were unhappy with Peter's school program and frustrated with the lack of progress in the development of a communication system.

Initial Evaluation

Peter's communication system consisted primarily of nonverbal communicative behaviors such as facial expressions, vocalizations, gross body movement, and eye gaze behavior used to communicate need and want states and maintain interactive contact with significant and familiar others. Peter had no symbolic system of communication. The school program had provided a "yes" symbol on the right side of his lap tray and a "no" symbol on the left side of his lap tray. All educational goals and objectives were aimed at training a yes/no response. Response reliability for yes/no was reported to be poor.

An evaluation of motoric functioning revealed that Peter had some voluntary but limited control of the right hand. Reported attempts to train switch access with the right hand were unsuccessful. Peter also had limited left hand and head control. A bio-engineering consult revealed that the optimal control site was the right hand.

Formal and informal evaluation of linguistic functioning revealed that Peter demonstrated receptive language abilities within the 2 year level. He demonstrated a severe oral speech dysfunction such that the prognosis for functional verbal speech was poor. Peter had no means for expressive language but was able to indicate choices nonverbally by touching objects and photographs placed to the right and left of midline with either arm. Response reliability varied due to both internal and external variables. Peter was unable to demonstrate his comprehension abilities in the distracting classroom environment. Consequently, the educational team were not in agreement with the findings on the non-oral communication evaluation and believed that his understanding of language was severely limited.

Cognitive evaluation revealed that Peter had signficant sensory processing limitations particularly with respect to the visual and kinesthetic modalities. Peter had poor control of eye movement and immature visual perceptual skills. Tactile sensation was impaired. His primary modality for sensory input was determined to be auditory. Peter demonstrated the rudimentary cognitive prerequisites for intentional communication and language, e.g. causality, object permanence, schemes in relations to objects, etc. (Miller, Chapman Branston, & Reichle, 1980).

Intervention Summary

There were two primary focuses of Peter's initial intervention plan: 1) develop motor skills necessary to access a single switch for scanning and 2) utilize existing motor skills for a direct select communication system. It was evident that Peter would ultimately require a scanning communication system. He obviously needed to develop some necessary prerequisites such as 1) volitionally hitting and controlling the switch, 2) visual perceptual, and 3) visual motor skills. In the meantime his present communicative needs were inadequately met with his current nonverbal communicative behaviors and the yes/no symbols on his lap board. It was determined that he was unable to identify the yes/no symbols and had not acquired affirmation/denial. This made it inappropriate to begin with yes/no as a preliminary communication system. It places the child in a responder role and is too abstract as a starting place (Bottorf & DePape, 1982). Peter needed to utilize his ability to select one of two pictures in a choice response format to make instrumental and regulatory requests using a direct communicative act and relay personal information such as feeling states.

The interdisciplinary team met to discuss the results of the evaluation and the intervention plan. The team agreed to implement the program. An index file of photographs and pictures representing Peter's core vocabulary were compiled. School staff were trained to present two plausible pictures to the left and right of midline on Peter's lap board in the presence of nonverbal communicative behaviors which were indicative of Peter's attempts to communicate needs, wants, and feelings. Consultation to the school staff was provided approximately twice monthly to implement the communication program. An appropriate positioning for motor training with a paddle switch was determined. Both occupational and physical therapists participated in motor training exercises. In addition, home therapy was provided two hours per week to implement the communication training program in the home. Parents were trained to present pictures and encourage choice responses rather than interpreting nonverbal behaviors.

Approximately 1 year after the initial evaluation Peter was able to identify 50 picture communication symbols with 90% accuracy. He was able to point to pictures in response to clinician's questions in both structured language tasks and communicative exchanges with 90% accuracy. Peter was able to make requests for objects and action from others using his picture communication symbols. He was able to relay feelings by pointing to picture symbols of "happy", "sad", or "angry". He was also able to respond to conversational exchanges using a choice response format.

Motor Training

Peter's paddle switch was mounted on the right side of a wood board. Peter was trained to access the switch with the prompts, "down, up, and back". He used his switch first to activate battery activated toys and then to use a Zygo 16, a light-activated communication board. Attempts to utilize the Zygo 16 as a communication system were unsuccessful. Peter lacked the visual/motor skills to use the Zygo and modifications of the design were not helpful. In addition, Peter required pre-requisite stepwise, or directed scanning skills before he would be able to use an automatic scanning system. He also needed auditory feedback when he advanced frame by frame on a light activated device in order to compensate for his poor control of eye-movements.

Upon the recommendations of the augmentative communication specialist, the parents purchased an Apple IIe microcomputer with necessary peripherals: color monitor, Echo IIE speech synthesizer, adaptive firmware card, motor training software and numerous language and early learning software. It was hypothesized that the computer would provide the team with a means for customizing Peter's educational and therapeutic program to meet his specific needs. Rather than purchasing a series of dedicated communication devices, we chose to invest in a versatile computer that would evolve with Peter as he developed.

When the computer-assisted education program idea was introduced at Peter's school, the team agreed to provide 1 hour per day of individual instruction with the Apple IIE in a quiet non-distracting environment. The school provided Peter with a computer in his classroom for communication and instruction. Using the Apple computer, Peter learned to access single switch software programs using his mounted paddle switch. The switch was connected to the computer via the adaptive firmware card. Peter was seated in his wheelchair insert at a small table when working at the computer. The mounted paddle switch was placed on the table and the color monitor was placed on top of the board to stabilize it. The microcomputer was out of reach and operated by the trainer. Peter was at eye level with the color monitor during training. Peter made steady progress in motor accessing using the Washington Research Foundation Motor Training Games. He was able to reliably access the switch on command within 3-5 seconds. He learned to hit and release the switch rapidly for stepwise scanning. Control of the switch was achieved using Motor Training Games such as Anti-Aircraft and Frog and Fly. Peter received auditory and visual feedback from the computer which directed him to hit the switch within a designated period of time. This helped him achieve greater speed and control.

Perceptual-Motor Training

In order to develop visual/motor skills, Target, a light activated communication board program was used. The program was first introduced with four light activated frames. A highly reinforcing object was placed on the color monitor in one of the four quadrants. Peter was required to hit his switch and advance the frame to light up the square containing the desired object. This required that he both hit his switch and visually attend to the monitor. Upon achieving 100% accuracy with this task, Peter was then required to select one of two, three and then four objects placed in each of the quadrants. Using plastic grids designed for photographs it was easy to attach a grid to the outside of the color monitor and then fill the pockets with small objects. We proceeded to photographs from here and then finally to picture communication symbols.

Language Training

Peter was unable to learn automatic scanning due to his severe visual limitations. Therefore, he was unable to use many of the commercially available single switch language programs. All language activities occurred with Target using miniboards with pictures or picture communication symbols. Peter was able to do a variety of receptive and expressive language tasks.

Communication Training

Peter learned to operate a four frame light activated communication board program with mini-board grids containing context and topic specific picture communication symbols. With this system he was able to achieve greater communicative potential, despite the fact that the system was not portable and still limited him to a finite vocabulary.

Peter reached a plateau in the development of visual/motor skills. We were unsuccessful in advancing him to more than a four frame display, and therefore had to consider alternative modalities for sensory input. Auditory scanning communication programs for visually impaired persons have recently been employed with multiply handicapped individuals (Fried-Oken, & Kowalski, 1985) After experimentation with an auditory scanning approach, Peter was able to successfully hit his switch to make choices from live voice presentation. He was able to select categories and then individual choices within categories using an auditory scanning method such that he could plan his meals, choose his clothes, and plan family outings. Using the auditory scanning method, Peter can have access to a much larger vocabulary then he can tolerate visually. While we are still in the training stage, the auditory scanning approach appears to hold great promise for Peter. We have recently received an auditory scanning software program compatible with the Apple and Echo IIe (Say It). We have developed a preliminary core vocabulary and have initiated a training program. Once Peter achieves operational competence using his auditory scanning program, the parents will purchase a small sized computer such as the Apple IIC, which can be attached to his wheelchair. The Cricket, a voice synthesizer comparable to the Echo, can be used with the Apple IIC to run the Say It auditory scanning program. Thus, Peter will soon have a portable and independent system of communication.

Summary and Conclusions

A program for facilitating early cognitive and communicative development for the severely physically handicapped, non-speaking child was presented. Children with severe physical disability are at a disadvantage for sensory-motor learning. The computer is a tool which enables the child to compensate for physical deficits and engage in an interactive learning process. The program described here calls for early and intensive intervention and introduces technology before a child is "ready" for augmentative communication. The program provides a mechanism for evolving into a communication system for the child.

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Fried-Oken, M., & Terry, E., (1985), Development of an auditory scanning communication system with mutliple voice output for severely disabled users. In C. Brubaker (Ed.), Proceedings of the Eighth Annual Conference on Rehabilitation Technology, Washington, D.C.: RESNA.

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Equipment References

Dedicated Communication Aids

Zygo 16
Zygo Industries Inc.
P.O. Box 1008
Portland, OR 97207

Computer Hardware

Apple IIE microcomputer
Apple Computer Inc.
Cupertino, California

Echo IIE speech synthesizer and the Cricket Speech Synthesizer
Street Electronics, Inc.
1140 Mark Ave.
Carpenteria, CA 93013

Adaptive Firmware Card
Adaptive Peripherals
4529 Bagley Ave. North
Seattle, WA 98103

Software

1) Motor Training Games
   Adaptive Peripherals
   4529 Bagley Ave. North
   Seattle, WA 93103

2) Fist Words I and II
   Laureate Learning Systems Inc.
   1 Mill St.
   Burlington, VT. 05401

3) First Verbs
   Laureate Learning Systems Inc.
   1 Mill St.
   Burlington, VT. 05401

4) Early Learning I
   Marble Systems
   P.O. Box 7012
   Rochester, MN.

5) Target or Target with Speech
   Communication Enhancement Ctr.
   The Children's Hospital
   300 Longwood Ave.
   Boston, MA. 02115

6) Say It
   Schneier Communication Unit