Using a Computer to Develop Early Communication Skills

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Abstract

Vocabulary learning and usage, motivational behavior, and social and communication growth were measured for eight severely handicapped toddlers under two different intervention conditions: a computer-based approach and traditional, individual play-based language therapy. Interventions, individual play-based language therapy. Interventions were administered in random order by graduate students in speech pathology. Videotapes were coded for both communication attempts and behavioral indices of attention and motivation. Communication growth was assessed using a standard set of communication-related measures administered before the interventions, at mid-point between the two treatment regimes, and after the second intervention. Notable progress was evidenced in both training conditions.

Introduction

Recent studies have shown the effectiveness of computer-based language intervention with young, handicapped children (O'Connor & Schery, 1986; Schery & O'Connor, 1992). Meyers (1986) suggests that the use of computers with speech output capabilities for language delayed toddlers under four years of age facilitates oral communication and promotes overall development, including motivation, attention to task, fine motor and visual scanning skills, as well as the acquisition of linguistic concepts. According to Meyers, computer interactions that allow the child to respond with the expenditure of minimal effort and which repeat items without fatigue are factors accounting for the rapid progress observed in some children. The current study is designed to examine and compare the effectiveness of two therapeutic intervention approaches for developing communication skill with a group of young severely handicapped children functioning at the initial stage of language development.

Method

Subjects and Settings

Eight handicapped toddlers enrolled in two infant intervention programmes in Los Angeles, California, served as subjects. When the project began, each child was non-verbal/non-singing or had evidenced use of no more than five consistent words or signs. A developmental level of at least fifteen months was established using the Cattell Infant Intelligence Scale (Cattell, 1960). In order to minimize the effect of prior environmental influences on initial language emergence, enrollment in the infant intervention programme for at least three months prior to participation in the research study was required. In addition, medical records established that any auditory or visual problems were corrected to within grossly normal limits.

The mean age of the subjects at the start of the study was 29 months (range 22-38 months) and the mean IQ was 64 (range 51 -82). There were five female and three malesubjects. Down syndrome was the primary diagnosis for

six of the children. One was diagnosed as an unspecified developmental delay and one was classified as emotionally disturbed. Associated sensory handicaps were present in four subjects; two children had histories of repeated ear infections, and one child had vision corrected by glasses and a history of ear infections. One child had prior surgery to correct ocular muscle imbalance. At the time of the study, no subject wore a hearing aid and all were judged as grossly normal for both vision and hearing. Socio-economic status, as indexed by occupation of primary breadwinner in the family, ranged from unemployed (1) to professional status (1). Family heads also included one unskilled laborer, two skilled laborers, two blue collar workers, and one white collar worker.

The focus of the programme at the two early-intervention facilities was to develop communication, self-help and social skills, as well as gross and fine motor abilities. Family oriented support services were provided as needed. The children attended the programmes for approximately three hours on three mornings a week.

Measurement Tools

The assessment tools used in the study are listed in Table 1. This set of measures was administered to each subject before any intervention training, again at the midpoint between the two conditions (except the Vineland, which was administered prepost only), and finally, within one week after the final intervention session. Additionally, the PEAL vocabulary was reassessed one month after the final posttest as a measure of retention. Formal measures included the Peabody Picture Vocabulary Test-Revised Edition (Dunn & Dunn, 1981), a norm-referenced test using plates of four pictures to which a child points when given a verbal stimulus. This test has norms down to age 2.0. Classroom teachers completed a standardized observational assessment of the children's language and language-related behaviour (Initial Communication Process Scale, Schery & Wilcoxen, 1982). This instrument consists of ten separate scales that measure aspects of communicative functioning and was normed on 360 multihandicapped children functioning in the 0-3 year developmental range. Reliability studies have established the usefulness of the ICP with teachers in special education classrooms. Formal parent interview information was gathered using the Vineland Adaptive Behavior Scale (Sparrow, Balla & Cicchetti, 1984), a standardized procedure that yields developmental age scores in the areas of Communication, Daily Living, Socialization, and Motor Skills.

Table 1

Measures Used to Assess Communication Gains

Norm-Referenced

Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn &Dunn, 1981)
Initial Communication Processes Scales (ICP) (Schery & Wilcoxen, 1982)
Vineland Adaptive Behavior Scales (Vineland) (Sparrow, et al, 1984)

Informal/Observational

Programs for Early Acquisition of :Language (PEAL) (Meyers, 1985)
Criterion Referenced Comprehension of Vocabulary (PEAL-Comp)
Criterion Referenced Production of Vocabulary (PEAL-Prod.)
Criterion Referenced Parent Report of Vocabulary Use (PEAL-Parent)

Videotape Coding

Communication Events

15 minutes of 1st and 12th sessions in each condition coded for use and comprehension of signs, words, vocalizations and keyboard access.

Behavioral Events

15 minutes of 1st and 12th sessions in each condition coded for attending, compliance and motivational behaviors.

Informal measures included a criterion-referenced test of the specific vocabulary items presented in the PEAL and videotaped coding of selected training sessions for each child. All 22 vocabulary items presented in the PEAL initial level were assessed, using objects, for comprehension (PEAL-Comp) and label production (PEAL-Prod). In addition, a parent of each child's use of these vocabulary items in the home was made (PEAL-Parent). Care was taken to embed the PEAL vocabulary items randomly in a larger set so that parents would not be aware of the actual words being trained. The first, middle (6th) and final (12th) treatment sessions of each training condition were video taped for each child. Videotapes were coded separately for a) communication attempts and b) behavioral indices of attention and motivation. Two observers separately viewed the videotapes and scored responses. Total responses were added and divided by the number of actual minutes in the training session. Interrater reliability was calculated using a point by point comparison.Tapes with reliability scores under 90% were viewed simultaneously by both coders and reviewed item by item until consensus was reached. Throughout this study, in both testing and training sessions, sign and vocal language were used to communicate with the children and responses were accepted in either modality.

Training Procedures

Two graduate students in Speech-Language Pathology conducted all treatment session. Each clinician was assigned to all sessions for children at a given school; therefore, one clinician worked with five children while the other saw three children. All training sessions at both schools were held with the child individually in a room adjacent to the child's regular group classroom.

Computer Intervention Condition

The computer intervention condition utilized the PEAL software (Programs for Early Acquisition of Language, Meyers, 1985). Only the initial level was utilized in the study. The vocabulary items were presented through one of two separate activities with differing themes (playing with a purse and its contents, and playing with wind-up toys). The Wind-up context featured six mechanical toys that couid be activated by the child. Each toy was presented along with a computer color-graphic representation of the toy. Six additional vocabulary items of actions that could be carried out using the toys were presented; these "action" items were also pictured on the computer screen. The Purse context featured five objects that could be played with and put into a purse (e.g. keys, beads). Again, six additional vocabulary item, actions that could be applied to the purse and objects were presented with corresponding color graphics. Hardware consisted of an Apple Me microcomputer with a Muppet Learning Keys keyboard. Pictures representing vocabulary items were available on 2-inch square pressure sensitive keys. As subjects touched the membrane keyboard, a large matching color graphic picture came up on the monitor screen and the picture was immediately labelled with synthesized speech. During these sessions, the clinician sat beside the child at a low table facing the keyboard and monitor. Objects, identical to the context vocabulary pictures, were displayed out of reach of the child on top of the computer monitor. Any time the child pressed an object key, the indicated object was given to the child for a brief play period. Verbal praise was given for attending or requesting objects and actions. Simple language was used to comment on the child's play with the objects. No direct demand for speech production was made. However, if the child did verbalize or attempt to sign a response, it was reacted to in the same way as a key press.

Traditional Language Training Condition

In the traditional sessions, the child and clinician sat together on the floor of a carpeted room. The toys from the alternate training context (Purse or Wind-up) that were not assigned to the computer condition were used here; that is, vocabulary was new for each child in each treatment condition. The toys were commented upon and played with in a semi-structured interaction. Initially, items were demonstrated by showing the appropriate use or function of the object, and the child was encouraged to interact with the clinician by imitating an action or initiating a play routine. In later sessions, the items were sometimes placed out of reach of the child so that the child had to request an item either by sign, gesture, or vocalization. The clinician was free to respond individually to each child's attention and interests. In general, she commented in simple language about what the child was doing, gave verbal praise for attending or requesting objects and cooperated in simple play routines. These sessions contained somewhat more movement and topic diversity, although no additional toys or items were introduced beyond the specified set.

Design

Two language treatment conditions, traditional language intervention (TRAD) and computer-aided intervention (COMP) were contrasted using a within subjects design where subjects served as their own controls. This helped to maximize sensitivity of effects, especially important due to the limited number of subjects. Each subject received twelve, 20-minute intervention sessions in each condition. The sessions were designed to be given twice a week for six weeks, but frequent absences prolonged the time for several of the subjects. Half of the subjects received the computer condition first and half received traditional language therapy first, order randomly assigned. The order was counterbalanced to control for order effects and possible differential motivation of the two vocabulary contexts. The relative effect of the two treatments was tested using a repeated measures (split-plot) design. The design was replicated f or two groups of four subjects each receiving the intervention treatments in counter-balanced order.

Because the use of many individual variables with so few subjects reduces the potential for detecting treatment effects, outcome measures were grouped into four general (summed) dependent variables by compositing the raw scores of scales, subscales and observations dealing with conceptually similar outcomes (see Table 2). The Language variable included both norm-referenced and criterion-referenced measures of direct language behaviour. The Prelinguistic/Related variable included raw scores on the eight subscales of the Initial Communication Processes Scales that theoretically contribute to communication readiness but are not direct communication attempts or responses. The videotape Communication composite variable included the total observed instances of production or comprehension of communication events as coded from the videotapes. Finally, the Videotape Behavior composite variable summed the raw score instances of observed positive behaviors of attention and motivation. Negative behavioral instances were subtracted from the total raw score. Constructing such composite variables reduces the number of individual variables and improves the reliability of the dependent measures, thus aiding the statistical power of the analysis (Lipsey, 1990). Subscale raw scores were

added without standardizing. The total score range within each composite measure was then examined to ensure comparability.

Table 2

Composite Dependent Variables

Language (Raw scors for the following were tatalled):

PPVT - R
PEAL - Comprehension (No. words indentified)
PEAL - Production (No. words used)
PEAL - Parent Report (No. words used at home)
ICP - Comprehension Subscale
ICP - Expression Subscale

Videotape - Communication (Total instances coded in 15 minutes)

Production (Child initiates communication)
Vocalization (rescored every 5 sec. if cont'd)
Device (times keys pressed)
Sign (recongnizable signs)

Comprehension (respnds to clinician with):
Oral Response
Device
Sign
Gaze
Manipulated Object

Prelinguistic/Related Skills (Raw scores for the followaing were totalled):

ICP - Auditory Skills Subscale
Visual Skills Subscale
Manual Fine Motor Skills Subscale
Oral Vocal Motor Subscale
Object Play Manipulative Subscale
Object Play Symbolic Subscale
Problem Solving Subscale
Affective Development Subscale

Videotape - Behavior (Total instances coded in 15 minutes)

Attends to Clinician (eye contact when spoken to)

Initiates Appropriate Behavior (appropriate non-verbal interaction with object or clinician)

Respond Appropriately (follows direct copmmand or request)
Off - Task Behaviors - Crying, Leaving Room, Finger Flicking, Throwing Object (rescored every 5 sec. if continued. This subtotal was subtracted from the cluster).

Results

Figure 1 shows schematically the outcomes on the Language composite variable. Cell means have been plotted for each group in each treatment condition overt the three testing periods: e.g. Group 1 received the traditional therapy first then computer treatment while Group 2 was reversed. A repeated measures test (MANOVA) revealed no significant treatment effect (Group x Time interaction: F(2,12) =.67, p<.532, see Table 3). However, an extremely significant time effect was found (F(2,12) = 42.43, p<.000), indicating both groups of subjects made notable progress over this four and one-half month period, regardless of the treatment condition.

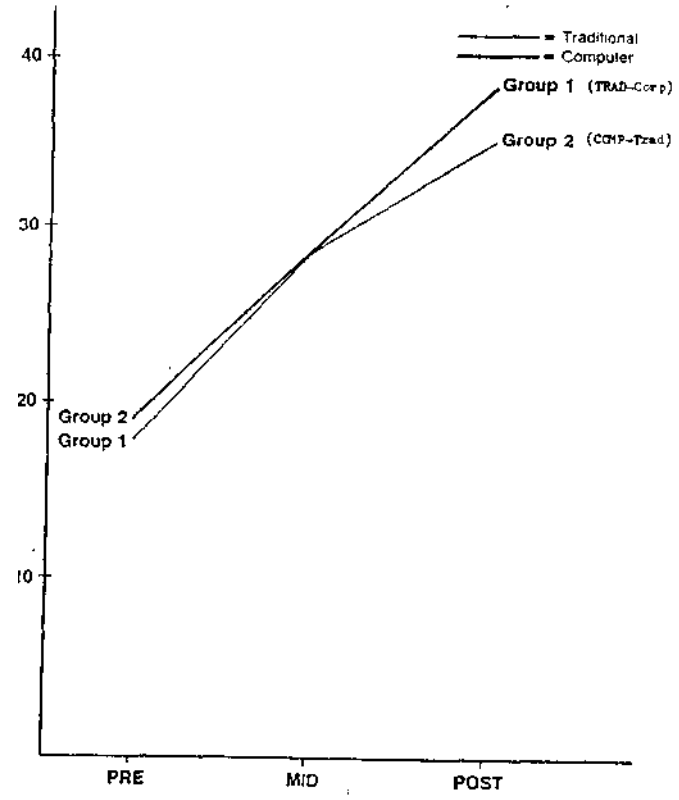

Fig. 1: Outcome Scores for Composite Variable Language

Table 3

Repeated Measures Outcome for Language Composite Variable

Source	df	SS	ms	F	P
Between Group (G)	1	3.38	3.38	.02	.895
SS within Group	6	1073.92	178.99		
Within Time (T)	2	1339.00	669.50	42.43	.000*
G x T	2	21.00	10.50	.67	.532 (main test)
Residual	12	189.33	15.78		

Figure 2 plots the outcome for the Prelinguistic/ Related composite variable. A similar, although somewhat less linear, pattern is observable. Here also the only significant result is progress over time (F(2,12)=37.05, p<.000, see Table 4). Both griups improved markedly from pretest to posttest, although for this variable the predominance of the gain occurred , during the initial treatment regime regardless of whether the child was receiving traditional therapy or computer-assisted treatment. This may have been influenced by a ceiling effect on some of the ICP subscales, discernable during the second period of treatment.

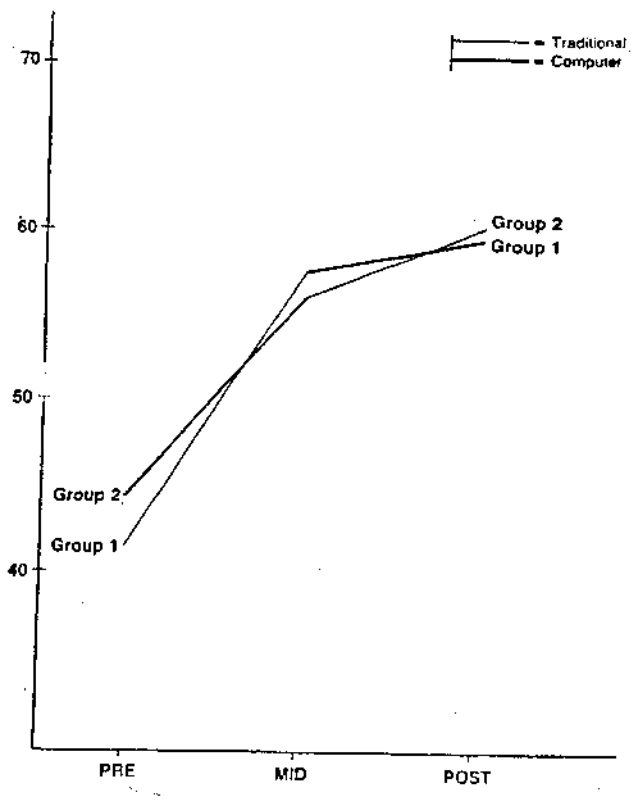

Fig. 2: Outcome Scores for Composite Variable Prelinguistic/Related

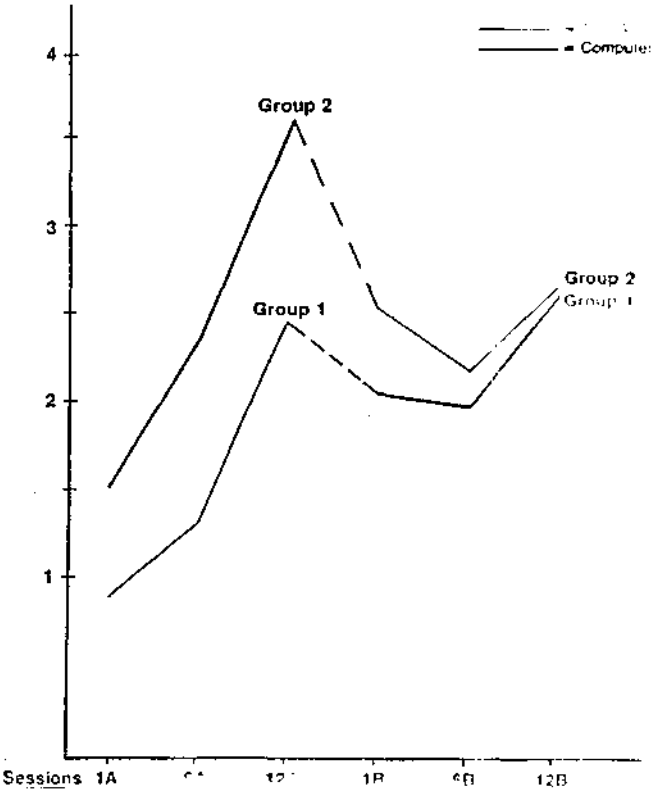

Fig. 3: Outcome Scores for Composite Variable Videotape/Communication

Table 4

Repeated Measures Outcome for Prelinguistic Composite Variable

Source	df	SS	ms	F	P
Between Group (G)	1	3.38	3.38	.03	.877
SS within Group	6	777.92	129.65		
Within Time (T)	2	1289.58	644.79	37.05	.000*
G x T	2	20.25	10.13	.58	.574 (main test)
Residual	12	208.00	17.40		

*Significant at p.<,001

Note: SPSS*MANOVA was used

Videotaped rating were analyzed in a similar repeated measures format. Figures 3 and 4 plot these outcomes. While these measures appeared somewhat more variable than the formal language test data, no significant treatment effect was detectable for either the communication coding (F(2,12)=.51, p<.612, see Table 5), or the behavioral coding (F(2,12)=.94, p<.419, see Table 6).

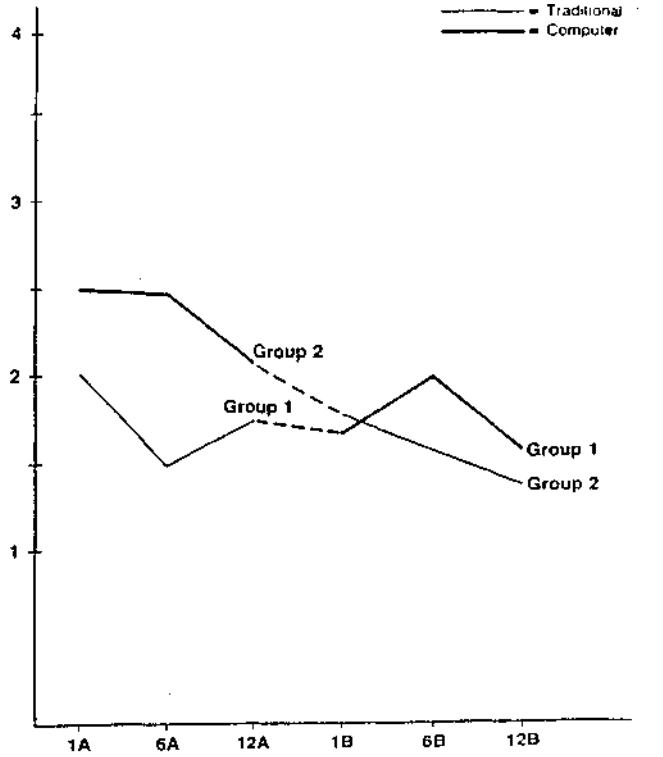

Fig. 4: Outcome Scores for Composite Variable Videotape Behavior

Table 5

Repeated Measures Outcome for Videotape/ Communication Composite Variable

Source	df	SS	ms	F	P
Between Group (G)	1	4.16	4.16	1.01	.354
SS within Group	6	24.73	4.12		
Sequence (S)	1	1.08	1.08	1.60	.253
G x S	1	1.57	1.57	2.33	.178
(within 1) .	6	4.06	.68		
Time	2	10.53	5.27	11.07	.002*
G xT	2	.01	.005	.01	.990
(within 2)	12	5.71	.48		
S x T	2	4.50	2.25	4.29	.039*
G x S x T	2	.54	.27	.51	.612 (main test)
(within 3)	12	6.30	.52		

'Significant at p.<.001
Note: SPSS" MANOVA was used

Table 6

Repeated Measures Outcome for Videotape/ Behavior Composite Variable

Source	df	SS	ms	F	P
Between Group (G)	1	.57	.57	.49	.51
SS within Group	6	"6.93	1.15		
Sequence (S)	1	1.81	1.81	4.96	.068
G x S	1	1.81	1.81	4.96	.068
(within 1)	6	2.91	.36		
Time (T)	2	.73	.36	1.21	.332
G x T	2	.11	.06	.18	.834
(within 2)	12	3.62	.30		
S x T	2	.29	.14	.41	.672
G x S x T	2	.66	.33	.94	.419 (main test)
(within 3)	12	4.72	.35		

Note: SPSS^X MANOVA was used

Table 7 shows that progress made over time on the Vineland Adaptive Behavior Scales, the formal parent interview instrument that was administered at the beginning and end of the total intervention program. Since it was not administered at the midpoint between the two treatment conditions, it could not be utilized in the analyses to compare differential progress. However, it is important documentation of how these children were functioning in their home environments before and after the four and one-half month period of communication-related treatments. Caregivers reported the most growth on the Socialization scale, but all areas showed discernable progress. Although gains were less than real elapsed time (except for socialization scores), the rate of growth was higher than would be expected based on the typical developmental progress of multihandicapped toddlers such as these. Uniformly, parents were pleased with the individual attention their child had received and the perceived progress. Table 7 also shows the results of the follow-up criterion-referenced testing of the trained PEAL vocabulary one month after the final training session and posttest. This testing showed that the children had maintained the gains documented! and, indeed, had continued to progress.

Table 7

Mean Scores on Selected Pre-Posttest Measures

Pretest (Mean Age = 29 months)	**PosttestfMean Age=33.5 months)**
Communication 13.8	Communication 16.3
Daily Living 17.5	Daily Living 20.3
Socialization 13.8	Socialization 18.5
Motor Skills 17.9	Motor Skills 20.5
PEAL Vocabulary (Raw Score)	PEAL Vocabulary (Raw Score)
Comprehension 2.3	Comprehension 7.5
Production 0.1	Production 4.1
Parent 4.6	Parent 7.2
Follow-up (Mean Age = 34.5 months)	
Peal (Raw Scores)	
Comprehension	8.6
Production 5.7	

Discussion

The results of this study suggest that when a computer is used in an interactive mode (i.e. guided by trained professionals), it can facilitate language growth in handicapped toddlers. The significant gains documented by both formal and observational assessments were equivalent to gains made in a traditional clinician-only language therapy programme of the same intensity and duration. In other words, children in this study made notable progress in language and related prelinguistic development regardless of the treatment condition.

In assessing the videotape ratings, the children randomly assigned to Group 2 (those receiving the computer intervention first) used slightly more communication attempts than did the four children

assigned to Group 1, although differences were not statistically significant. Both groups decreased their communication behavior from the end of the first condition to the beginning of the second condition, perhaps reflecting a resistance to a change in therapy procedures. However, by the twelth session, communication levels were essentially comparable. The behavioral coding showed an overall slight decrease in "on task" behavior across both conditions. However, it should be noted that means for this measure were greatly influenced by two children with highly variable tantruming behavior who may have unduly influenced the group averages. There was also a trend for the computer condition to facilitate "on task" behaviors: this was the only variable for which the computer condition showed any advantage over traditional therapy for both Group 1 and Group 2, although this difference was not so marked as to reach statistical significance. Perhaps the greater degree of structure in this condition was helpful here. It may be that this would be an advantage for certain categories of handicapped children.

Although not formally assessed in this study, individual interaction with a responsive and perceptive adult may have been the critical variable in effecting communication growth. In both treatment conditions, a student clinician provided personal support and attention to each child individually. In order to examine more carefully the relative effect of this influence, future studies would need to contrast computer-based interventions presented with and without the presence, of a facilitating adult. If the presence of such an adult is not necessary for effective progress, a significant expansion of computer-based interventions for use as an adjunct to therapy and for additional practice might be advocated.

Given the current results, it appears that while computers are not of themselves more successful than traditional language therapy, they can be used to facilitate language growth in young handicapped children. Such devices, when accompanied by a monitoring adult, can potentially assist such children in becoming effective communicators. There may be some distinct advantage to this procedure for the beginning therapist or for a paraprofessional who is not qualified to deliver a traditional therapy regime. A particular advantage to voice-producing computers exists; non-verbal or difficult to understand children can use the computer to "talk". Thus, the computer can serve as an augmentative system, giving the child an opportunity to engage in meaningful dialogue with caregivers during selected home or school interactions. With little modification, such as the addition of two access keyboards, the child could also use the computer to interact with peers. In both cases, the computer serves as a tool that encourages communicative turn-taking in dialogues. This is very important since the quality of a severely handicapped person's life can be markedly affected by the degree to which they can make wants known and can influence

the social environment around them (McCormick & Shane, 1990). More research is needed to understand how best to implement this technology into home and school environments so that multihandicapped children can communicate most effectively at an early age.

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