A Survey of Microcomputer Applications in Aural Rehabilitation

Donald G. Sims
National Technical Institute for the Deaf
Rochester Institute of Technology

Lennart L. Kopra
University of Texas at Austin

Robert J. Dunlop
Olin E. Teague Veterans' Center

Martha A. Kopra
University of Texas at Austin

Three types of computer-based education in aural rehabilitation are described: (a) computer-managed instruction, (b) computer-assisted instruction, and (c) computer-assisted interactive video. Hardware, software, and supportive resource options for computer-based education are discussed. Appendices provide information on software for audiologic applications and sources of special video-to-computer interface cards.

The proliferation of computers used for education is astounding. For example, half of the 5-7 million households that have computers use them for educational purposes (*Popular Computing,* 1984). In 1980, only 21% of all United States high schools owned one or more computers for student use. By the fall of 1983, that figure had risen to 86% with some 325,000 computers installed. The typical high school owned five computers (Schneiderman, 1984). Molnar stated, "It used to be that you couldn't have a school unless you had books and a library; now you can't have a school of excellence without having a computer or computer-based system" (*Popular Computing,* 1984, p. 35).

Although the computer revolution is upon us, there is work to be done

Donald G. Sims is Associate Professor of Audiology, Department of Communication Research, National Technical Institute for the Deaf (NTID), Rochester Institute of Technology, Rochester, New York 14623-0887. Lennart L. Kopra is Professor Emeritus of Speech Communication, Department of Speech Communication, University of Texas at Austin, Austin, Texas 78712. Robert J. Dunlop is Chief, Audiology Section, Audiology/Speech Pathology Service, Olin E. Teague Veterans' Center, Temple, Texas 76501. Martha A. Kopra is Research Associate, Department of Speech Communication, University of Texas at Austin, Austin, Texas 78712.

before computer-based education lives up to its potential and is something more than an automated and animated work sheet. The broad term, computer-based education (CBE), has recently been used to include computer-assisted instruction (CAI) and computer-managed instruction (CMI). Another term, computer-aided learning (CAL), has also surfaced.

CBE began in the 1960s and followed the behavioral self-instruction models of the time. There are three important differences between CBE of the 60s and now. First, CBE is currently divided into CAI as the instructional component and CMI as the administrative and learning management component. The second difference is that both CAI and CMI have moved from large, expensive mainframe computers to microcomputers. Third, the use of videotape and videodisc under computer control, termed computer-assisted interactive video (CAIV) instruction, has greatly enhanced CAI as an educational tool.

The purpose of this paper is to discuss the scope of CBE and the application of computer technology to aural rehabilitation. Applications that incorporate computer-assisted interactive video (CAIV) are highlighted. Also, an overview of the computer hardware, software, and support resources required in aural rehabilitation is provided.

COMPUTER-MANAGED INSTRUCTION

CMI uses a computer to (a) gather and summarize student data, (b) store and retrieve demographics and test data, and (c) monitor progress towards instructional objectives. Smaldino and Traynor (1984) are developing a microcomputer case management system which encourages graduate students to focus on sequencing in aural rehabilitation. Case history information and data from diagnostic tests of auditory and visual perception, manual dexterity, language, and cognition are combined with hearing-aid performance measures. A printout shows a recommended, stepwise sequence of aural rehabilitation activities. Harlan (1982) and Lotterman (1985a) also developed a series of microcomputer programs for reporting clients' audiologic data and case history information, including speech-language development.

Grossman, Siders, and Garraway (1983) applied "precision" teaching principles to computerized sign language instruction. A data base containing features for motion, placement, handshape, and linguistic content was established for each sign presented during the course. Students' speed and accuracy of expression and reception on a series of one-minute tests is entered into a computer; a printout of student progress, with reference to the performance standards, is obtained.

Rushakoff (1984a) listed several programs that allow speech-language and hearing clinicians to generate individual education plans (IEP) and maintain therapy data logs. An example of a commercially available package to generate IEP reports is the Berryman and Johnson (1984) program. Demorest and

Erdman (1984) adapted dBase II, a commercially available database management system, for use with a self-report inventory they are developing.

Hood and Miller (1984) described administrative uses of computers for graduate education in speech and hearing. Their mainframe software applications include reporting student clinical experiences in a format conforming to ASHA certification requirements. The software also can generate reports of client services by type of disorder and clinical practicum site. Client demography and billing information are other features available.

In general, whenever CAI becomes operational in a curriculum, there will be a need for CMI to generate reports so that instructors can monitor student attendance and performance on a regular basis. These reports should include only essential information that does not bury the teacher in data. To improve instructional efficiency, items which are either too easy or too difficult can be easily culled after accumulated student performance data have been examined. Depending on the design of the lesson, performance can be measured by the number of correct responses or the response time required for a correct answer (Sims, Scott, & Myers, 1982).

COMPUTER-ASSISTED INSTRUCTION

CAI provides direct instruction with feedback to learners on their performance. CAI usually supplements classroom or group instruction, providing reinforcement and drill that teachers cannot conveniently provide on an individual basis.

Advantages of Computer-Assisted Instruction

CAI has all the advantages of programmed, individualized instruction, plus the potential for interaction with learners. Rate of instruction is dictated by students' skills and knowledge of materials as well as by their learning styles. Feedback to students concerning performance can be provided instantly because computer programs can constantly analyze progress and coach students on better strategies for solving problems in exercises.

Computer languages such as LOGO, developed by the Massachusetts Institute of Technology's (MIT) artificial intelligence laboratory, are being used to stimulate formation of mathematical concepts, spatial relations, and sequential logic processes in young children. The computer is used as a tool for exploration of concepts, rather than as a drill and practice machine. This practice has recently been termed computer-aided learning (CAL).

CAI also allows teachers to ensure mastery of the lesson by every student. This may be done by repeating instruction until a criterion level of performance is achieved; however, this design is not good CAI. Interaction should provide alternative approaches to learning the skill or concept when students are initially unsuccessful.

The popularity of videogames, which generate a drive for mastery, has resulted in attempts to incorporate the videogame approach into CAI. According to Driskell and Dwyer (1984), videogames thoroughly engage players because they provide action activities that are competitive and challenging and involve fantasy. Players also receive immediate feedback regarding performance. With these elements, CAI can motivate students toward mastery of skills or concepts being taught. Fast-paced, game-like lessons with interesting graphics require highly skilled programming. One must be careful not to slow student progress by bogging the computer down in elaborate graphics routines. Readers are directed to Shearer's (1984) thorough treatment of CAI.

Applications in Aural Rehabilitation

In this section, three basic types of CAI are described: (a) drill and practice, (b) tutorial, and (c) simulation.

Drill and Practice. Once a concept has been explained, students must practice in order to improve retention and build functional use of the information. Auditory training and speechreading training often involve drill and practice (Walden, Erdman, Montgomery, & Prosek, 1981). CAI can make this essential activity effective and one that students perceive as helpful.

Mills and Thomas (1983) designed a five-program set for evaluation and treatment of auditory comprehension and memory impairment in language-impaired adults and children. Objects are represented and coupled with speech synthesizer output for drill and practice. There is good control of stimulus parameters and student performance data, including response time.

Using the PLATO mainframe system, Saunders, Hill, and Simpson (1980) developed *tactile* speech perception training for profoundly deaf children. Natural speech stimuli were recorded on a computer-controlled disk and then converted into tactile patterns by a prototype 20-channel display worn on the abdomen. Students felt single words while viewing their graphic representations. A touch screen was used to ask for repetition or to enter a discrimination response. Previously learned words were later presented in short sentences with a four-choice response format.

Sims et al. (1982) reported on the use of CAI at the National Technical Institute for the Deaf (NTID). Their first effort included random access of audiotape stimuli for discrimination of telephone signals. A later project involved auditory vowel discrimination on the PLATO system as part of basic auditory training.

Hight (1981) developed a graphic representation of mouth shapes for speechreading drill and practice. Students type a word or phrase on the computer keyboard and see the mouth shapes for each phoneme in sequence. Co-articulatory influences on mouth shape are not part of the program. A number of computer-supported programs to represent articulation and prosody visually to deaf learners are reviewed by Braeges and Houde (1982).

Henoch (1985) is using a speech recognition device, Voice Entry Terminal (VET), developed by Scott Instruments, primarily for articulation and language therapy. A commercial software program designed for teaching foreign languages will be modified to be used with this system.

Tutorial. Tutorial lessons in CAI are instructional modules that develop concepts by presenting, for example, definitions, descriptions, examples, and problem-solving activities. In general, tutorial CAI exercises are more content-, rather than skill-, oriented. An example is the Rushakoff (1984c) *Microcomputer Assisted Study Partner in Anatomy and Physiology of the Speech and Hearing Mechanism.* This set of software was written by speech and hearing faculty in SuperPILOT authoring language on the Apple II with color graphics to provide a self-study supplement for basic anatomy courses in graduate communication disorder programs. Lotterman (1985b) developed a number of computer modules for support of introductory graduate level coursework in audiology. Topics reviewed include decibel notation, audiometric interpretation, masking, and immittance.

Simulation. Simulations test the application of learned concepts in a quasi real-life situation. It is challenging to instructional developers because important circumstances for problem solving should be anticipated and included in the program. Some graduate training programs are using microcomputer simulations of hearing testing to provide students practice with masking and diagnosis of site of lesion (Zimmerman, 1984; Lotterman, 1985b).

A simulation of a job interview, developed at NTID, uses a videotape under computer control and represents one use of CAIV (Cronin, 1979). The purpose of the simulation is to help students assume responsibility for successful communication despite hearing loss. Students fill out a job application on the computer screen via the keyboard. Then, prerecorded video segments of the interviewer asking questions are shown. Depending on the students' answers, various other video sequences are seen. Thus, each student has a unique path through the simulation and may or may not "get the job" in the end.

INTERACTIVE VIDEO

CAIV instruction enriches CAI with motion, color, and sound. Video images under computer control are presented to students who interact with the computer. Presentation of a particular sequence of images from videotape or videodisc is dependent upon students' previous responses.

Uses of Videotape

A concerted effort to apply videotape to speechreading instruction has been made at NTID to supplement group instruction with self-instruction (Jacobs, 1975; Sims, 1978). Drill materials covered familiar expressions and job-related sentences. Among the advantages of using instructional television for speechreading, Jacobs (1982) listed these: (a) group instruction can be supplemented with individual training, and (b) anxiety of poor lipreaders and boredom of better lipreaders in a group situation is relieved.

Observations of students using these self-instruction videotapes indicated the need for computer assistance. For example, when students wanted to repeat a stimulus, a minimum of 30 seconds was required for the tape to be manually stopped, rewound, and replayed. Consequently, students seldom repeated individual items and mastery of the materials could not be assured.

Subsequently, NTID developed an interactive system to control videotape, called the Data Analysis Video Interactive Device (DAVID) (Sims, vonFeldt, Dowaliby, Hutchinson, & Meyers, 1979; Cronin, 1979). Further development of the DAVID system (now renamed, Dynamic Audio Video Interactive Device) included sign language instruction (Newell, Sims, & Meyers, 1983). The DAVID hardware consists of a random-access video controller (BCD 232 LINK) and modified videotape recorder (JVC BR 6400). The host computer (Apple IIe) uses one to three disk drives to store the lesson, student, and program data.

About 100 deaf college-age students at NTID use the microcomputer-based system each quarter. There are over 2,400 everyday, job-related, and English syntax practice sentences presently recorded. Depending on their speechreading skill, students use one of three response formats: multiple choice, fill-in-the-blanks, and open set (with or without audio). Programs include a "help" function which gives a hint about the sentence topic and a letter or word that was incorrect or missing from the response. Use of the help function is monitored, and the program coaches the student in its use when the student is having difficulty obtaining the correct answer. All of the students' keystrokes, response times, and instructional paths through the lesson are stored on disc.

Pre- and posttest measures of speechreading gain, as well as students' attitude toward computer-assisted drill, compared favorably to videotape drill without computer control (Sims et al., 1979). In addition, Sims (1984) studied tabulations of response times, number of requested replays of the stimulus, and number of helps requested in order to obtain a correct response. All of these measures showed a downward trend, indicating that students became more skilled at the task over the course of the drill.

Uses of Laser Videodisc

The videodisc is "an LP record-like storage medium for audio visual materials" (Alberta Educational Communications Corporation, 1983, p. 5). The type of videodisc discussed in this section is the laser videodisc — a laser, instead of a needle, is used to retrieve the information from the disc. Both still-frame and motion sequences can be stored on the disc from sources such as print, photography, film, and videotape. These images are etched onto a master videodisc. At the present time, videodiscs cannot be altered once they have been produced. Although both videotape and videodisc players, under external computer control, can randomly select segments to be played, the laser videodisc is unique because (a) no stylus touches the videodisc, (b) there is no wear on the disc, and (c) video segments can be accessed quickly and accurately.

Kopra, Dunlop, Kopra, and Abrahamson (1985) reported on a computer system and software designed for an Auditory-Visual Laser Videodisc Interactive System (ALVIS) which is used for drill and practice in speechreading CAI. The system includes a laser videodisc player, microcomputer, keyboard, video monitor, two microfloppy disk drives, dot-matrix printer, external amplifier and attenuator with associated accessories, and earphones. Twelve lists of 25 sentences each were standardized and arranged in order from easiest to most difficult to speechread. These five-to-eight word sentences were recorded on one-inch videotape and then pressed on videodisc.

ALVIS is being used experimentally in a program of aural rehabilitation which includes speechreading instruction for postlingually hearing-impaired adults. The goal is to examine the effects of supplementary drill with a CAIV system on the development of speechreading skill. Presentation of a talker saying each of 300 sentences is under software control by ALVIS. During a lesson, each sentence is presented a maximum of five times; the first presentation is without any clues. In one condition, ALVIS/cluewords, no sound is used and word clues are printed on the video monitor. In a second condition, ALVIS/hear, auditory clues accompany the visual stimulus.

One of the first uses of interactive videodisc in the education of deaf children was reported by Brawley and Peterson (1983) at the California School for the Deaf at Riverside. Language and reading skills are taught via ten intervention formats. Brawley and Peterson (1983) stated, "The student is automatically branched through . . . activities, which require him or her to acknowledge captions appearing on the screen; sequence events; recognize correctness of syntax; respond to questions; and categorize, spell, capitalize, punctuate, and construct sentences and questions" (p. 686). An interface card permits the computer to combine computer-generated text and student tasks with external video. The student primarily uses a light pen to interact with the system, but uses the keyboard for spelling tasks. The same video sequences can be used for many different reading levels, language concepts, and instructional objectives because instructions and captions are not on the videodisc but are inserted by the computer program.

Costs

The cost of producing a 30-minute videodisc may be too high for rehabilitation facilities. Some commercially available videodiscs produced for educational or recreational purposes could be repurposed (St. Lawrence, 1984). Repurposing is the use of a disc for a purpose different from the one for which it was originally intended, for example, music education. In one aural rehabilitation project, a Sony demonstration disc is being used to train patients to listen to increasing levels of sound, both while viewing the speaker and without viewing the speaker, as the speaker continues to talk (Kopra, Kopra, Abrahamson, & Dunlop, 1985). The advantages of repurposing are reduced cost and variety of materials; the disadvantage is the difficulty in applying those materials. For instance, it may be difficult to find a videodisc that has sentences and speaker position appropriate for speechreading drill.

Differences Between Videotape and Videodisc

When one contrasts videotape and videodisc for CAIV instruction, a number of advantages and disadvantages become apparent. Magel (1985) commented, "There are major differences that can be measured in dollars, image quality, seconds, microns, and feet" (p. 31). Current availability, cost, durability, flexibility, and access time are factors to be considered.

Videotape players are widely available in educational and service facilities where videodisc players are rare. Videotapes are easily reproduced; videodiscs are not. However, videodisc technology has been applied widely in the Armed Forces and in industry. Over 3,700 videodisc players are used by the Armed Forces for the education of military personnel and the operation of complicated equipment such as tanks (Videodisc Monitor, 1985). In the automobile industry alone, 15,500 videodiscs are used for training, demonstration, and development. It is apparent then that, in large scale applications, videodisc materials become highly efficient as well as effective.

The cost of hardware is about the same for videotape and videodisc (Magel, 1985), but if materials need to be updated frequently, or if less than 100 copies are needed, then videotape is considerably less expensive.

Preparation of Videodiscs

A commercially available optical disc recorder (Panasonic TQ-2023) for on-site production of videodiscs is commercially available for $30,000. Each non-erasable 15-minute disc costs $750. Discs recorded on this machine are not compatible with other videodisc players.

To prepare a standard videodisc of the kind used in business and entertainment, a videotape master must be made of professional studio quality. Many individuals in aural rehabilitation do not have access to television production facilities that are capable of professional preparation of videotapes, nor do they have the funds to purchase this type of service. Magel (1985) quoted a vice president of a major producer of interactive medical programs:

> For high-end video, there is no significant difference in production costs between interactive tape and disc. To achieve similar professional results, the elements of scripting, talent, directing, lighting and camera are the same. The cost difference comes in the post production (activities such as careful editing). (p. 58)

Another expensive item in the preparation of videodiscs is the mastering charge. The current cost of pressing a master videodisc from a 30-minute one-inch videotape is approximately $2,000. Replications (dubs) of this master cost about $20 each. By ordering 100 or more replications of a master, the cost of videodiscs may be the same as the cost for an equal number of videotapes (Schneider & Bennion, 1981).

Unlike videotapes, videodiscs can be handled extensively without damaging them; there is no image deterioration, wear, or stretching. One can "freeze" a single frame on videodisc playback and display it indefinitely without any damage to the videodisc. The 3M Company estimates the longevity of the disc at 600 years (McConnell, 1983). However, the fact that videodisc content is permanent can be disadvantageous. Because videotape can be altered, it is a more flexible medium for some applications. For slides, videodisc is superior: 54,000 slides can be stored on a 30-minute videodisc. On videotape, each slide would have to be recorded for as long as the slide is to be presented. Despite differences in storage capacity, with a computer both media can achieve comparable interactivity.

The distinct advantage of the laser videodisc is immediate and precise accessing of any frame in any order (random access) or in any mode, for example, still frame (normal speed) or slow motion. The search time from the first to the 54,000th frame does not exceed 5 seconds. In contrast, accessing a single frame on a videotape is a sequential process because the tape must spool past the player's read head. To fast forward a videotape from the beginning to the end of a 30-minute segment takes 3 minutes. To rewind it takes 1½ minutes. However, videotape access time can be reduced with careful editing. By placing the more frequently used items at the center of the tape and working outward from the center, less time will be needed to access the programmed frames. With videodisc, geographic location does not usually make any difference because access times are so short. The instructional need for high speed access is greatest when the student views very short stimuli (less than 10 seconds) and when access will be random as in a look-up or dictionary type application. If longer stimuli are used, or the instructional path is fairly linear, then videotape access is adequate.

COMPUTER HARDWARE, SOFTWARE, AND SUPPORT RESOURCES

A computer system in an aural rehabilitation setting requires careful planning. Decisions concerning hardware, software, and support resources must be made concurrently because the computer system functions as a unit and will be only as strong as its weakest link. The first step in selecting a system is evaluating the aspects of the aural rehabilitation program which can benefit from computer assistance. Then, any existing software relating to program goals should be examined. If existing software meets the needs of the program, hardware may be purchased which executes the software of choice. This sequence is specified because computer hardware is relatively inexpensive when compared to time and dollar costs for computer programming.

If no useful software exists, then the computer hardware purchased will be derived from a listing of all specifications required of the CBE activities which are to be developed. A consulting computer systems analyst will be of great help in this regard.

The audience who will use the system should be identified. If clinicians, instructors, and college students will be the primary users, then only the basic educational requirements need to be addressed. However, if young children, older adults, or persons with special handicapping conditions are to be hands-on users, then system design must be consistent with their abilities. Specifications should include how the learner is to interact with the computer, for example, by typing a sentence, pushing a key for closed-set responses, or moving a cursor on the screen. Besides age and physical limitations, computer sophistication, typing experience, and the physical layout of the environment need to be evaluated.

The physical demands of a computer work station are not the same as those of a typical secretary's desk. Common problems are (a) high light levels, produced by typical overhead fluorescent lighting and sunlight, which often cause glare on a monitor, (b) poor seating, which causes back and arm aches, (c) high noise levels from a printer, and (d) inadequate storage space (Cutler, 1984; Lewell, 1985). The work station layout in aural rehabilitation can also become complex because of numerous peripheral devices.

Hardware

Aural rehabilitation requires special storage devices, such as videotape and/or laser videodisc systems, that yield high quality audio and video images for use in speechreading, auditory training, and other CAI applications (Kopra, Dunlop, & Kopra, 1984; Sims, Snell, & Clymer, 1984). Although each system in a stand-alone operation may work well, special interface boards may be required to place video playback units under computer control. In Appendix A, sources and general specifications for some of these video interface boards are listed.

Usually, the most neglected computer peripheral device is the monitor. Monochrome displays are best for text editing and may produce characters in amber, green, or white on a black background or in reverse video. Color monitors are best for graphic displays and live-action video. If simultaneous use of graphics and text is desirable, then one might consider the newer monitors which are switchable from high-resolution, RGB color, to composite video input from the video playback.

Eighty-column displays are best for text; monitors that offer higher resolution are easier to read. Resolution is commonly measured in lines (Utz, 1985) or in pixels (picture elements or dots). Another factor which affects resolution is the computer's character matrix generator which defines how many dots are used to create each character (Coach, 1984). This number can range from 35 to 300 dots per character. One must be aware that some computers may not be able to generate a sufficient character matrix to adequately use the capabilities of a high resolution monitor. A simple way to observe differences in resolution is to plot a circle on the monitor screen. Lower resolution screens show a choppy stair-step arc, while higher resolution systems have a more gradual curvature. Some computer systems allow selection of different levels of resolution. Through software commands, different screens or modes can be used, allowing higher or lower levels of graphic resolution. These different screens will produce texts of 20, 40, or 80 columns.

For further information, the reader is referred to Chial (1985a) to learn about CPUs, memory, storage devices, output devices, and interfaces.

Software

Appendix B lists many software packages currently available for audiological applications including drill and practice in hearing testing, hearing aid preselection database routines, and CAI in anatomy and physiology. Detailed program description, critiques of program function, and compatibility restraints for software related to speech and hearing are provided in the software review section of *Asha* and the *Journal for Computer Users in Speech and Hearing.* Reviews of general application software (word processing and database management programs) can be found in popular computer magazines such as *Byte, PC World, InCider, A+*, and *Personal Computing.*

As suggested by Chial (1985b), it is always good practice to evaluate software thoroughly prior to purchase in order to ensure that it produces the desired results and is hardware compatible. Software for special applications, such as speech, language, and hearing, is usually only available for hands-on demonstrations at conferences and conventions. However, one can easily consult others who may have used the software and who can provide an unbiased opinion of its performance. Jackson (1984) also advises buyers to be aware of hardware requirements. A $50 software package can become very expensive if $500 worth of special boards or other peripherals is needed to fully use the material. Furthermore, Rushakoff (1984b), warns the user to determine if a *specific* hardware brand is required to use the software. He noted that some software packages which access speech synthesizers will run only on particular brands of speech synthesizers and not on others.

Much of the available special purpose software is for speech pathology programs. With the exception of several hearing aid selection routines, few application programs are being used in aural rehabilitation. Some software is being more generally applied. The Aphasia I, II, III programs distributed by Parrot Software have been used by several institutions for teaching language to the deaf (F. Weiner, personal communication, September 24, 1985). As the current interest in computer use in aural rehabilitation continues, more software will be adapted and developed.

Support Resources

Support resources may include personnel to set up and operate the equipment, technical support to provide hardware modification and repair, and programmers to edit and prepare special software. Programmer support will continue to be a necessity in the near future as few application packages are commercially available that apply directly to speech and hearing (Rushakoff, 1985). This paucity of software means that a significant amount of time must be spent in adapting software developed for other applications or creating one's own software for aural rehabilitation.

Other support is required in the area of reference publications and special interest groups. Many journals and magazines concerned with computer applications in general review software and hardware, provide answers to specific interface and application problems, and explain how specific tasks can be accomplished more efficiently. The annual computer conference of the American Speech-Language-Hearing Foundation highlights new software and hardware and provides hands-on evaluation. Local special interest groups and electronic bulletin boards are also good sources of information.

FUTURE APPLICATIONS

As the computer grows in popularity in speech and hearing centers, users will continue to find new and unique ways to use this tool. In addition to word processing and database applications, there are many teaching, clinical, and research areas for development. Computer assisted case history taking, assessment, and management of intervention strategies such as is being developed by Smaldino and Traynor (1984), could systematize the rehabilitation process. Kopra, Abrahamson, Dunlop, and Kopra (1985) also are beginning to use a computer modified version of the Hearing Performance Inventory toward this end. CAI or CAIV programs could be developed for training clients in the use of coping strategies when communication fails, and for hearing aid orientation.

Jerger and Fifer (1984) stated that CAIV instruction with laser videodisc technology is a logical adjunct for training clients to use cochlear implants as lipreading aids. Boothroyd (1985) has begun using interactive videotape in a lipreading tracking procedure for cochlear implant users.

At the university level, aside from the academic uses now in place, applications of CAIV may include simulation of real-life experiences for students, for example, case history interviews, counselling of clients and their families, and interaction with clients who are difficult to test. CAIV programs for training sign language would also be helpful (Newell, Sims, & Myers, 1983).

Research

CAI and CAIV permit a degree of control over the rehabilitation process which can facilitate research. Methodology and stimulus variables can be studied free from teacher/clinician and stimulus presentation effects. For example, with CAIV, one has rapid random access to prerecorded video segments with control of every video frame (1/30 of a second). This permits detailed study of a speechreading stimulus and the influence of frame rate on speechreading training. Any number of visual perceptual tasks can be programmed and compared. For example, exercises using discrimination, recognition, and/or comprehension paradigms could be compared for instructional effectiveness (Sims, 1985). Kopra, et al. (1984) have begun to use a programmable attenuator in the audio circuit of a Sony CAIV computer system. If sound is used, any desired intensity can be programmed for auditory training or auditory/visual tasks.

With all this technical promise offered by CBE, there has not been a significant amount of research reported as to its effectiveness in aural rehabilitation. CBE will be as short lived as other educational fads if we fail to consider *validation* of learning to be as important as the content and process of instruction. This implies that CBE authors should commit themselves to long-term ecological studies which demonstrate efficacy.

While considering future applications of the shiny new high technology device, one must still keep in mind the fact that the old devices still work and still perform important functions. In the rush to have the latest gadgetry, old standbys will probably continue to be the workhorses until (and after) new technology is in place. Also, one should *never* expect that CAI will be better than individual therapy with a seasoned clinician. CAI is only as good as the programmer makes it and considerably less flexible than a clinician when a client acts in unpredictable ways. When it is not feasible to have one-on-one therapy for extended periods of time, high quality CAI, which has been proven effective, is a reasonable alternative.

ACKNOWLEDGEMENTS

The preparation of this report was supported in part by a contract between the Veterans Administration Rehabilitation R&D Service and the University of Texas at Austin.

REFERENCES

Alberta Educational Communications Corporation (ACCESS). (1983). *A literature review of computer based multimedia training for the Alberta Solicitor General Department.* Edmonton, Alberta, Canada: Author.

Berryman, J., & Johnson, R. (1984). *Planning individualized speech and language intervention programs* [Computer program]. Tucson, AZ: Communication Skill Builders.

Boothroyd, A. (1985, October). *Recent advances in audiology: Applications to hearing-impaired students.* Paper presented at the A.G. Bell/NTID Conference on Applied Technology for Communication, Rochester, NY.

Braeges, J.L., & Houde, R.A. (1982). Use of speech training aids. In D.G. Sims, G.G. Walter, & R.L. Whitehead (Eds.), *Deafness and communication: Assessment and training* (pp. 222-244). Baltimore: Williams & Williams.

Brawley, R.J., & Peterson, B.A. (1983). Interactive videodisc: An innovative instructional system. *American Annals of the Deaf, 128,* 685-700.

Chial, M.R. (1985a). Evaluating microcomputer hardware. In A. Schwartz (Ed.), *Handbook of microcomputer applications in communication disorders* (pp. 86-111). San Diego: College Hill.

Chial, M.R. (1985b). Student computer facilities: A guide to strategic planning. *Leadership training in computer technology* (pp. D.1-D.9). Washington, DC: American Speech-Language-Hearing Association.

Coach, K. (1984). Televisions as monitors. *Byte, 9*(7), 171-176.

Cronin, B. (1979). The DAVID system: The development of an interactive video system at the National Technical Institute for the Deaf. *American Annals of the Deaf, 124,* 616-618.

Cutler, I. (1984, November). Designing the office around the computer. *Personal Computing,* pp. 82-86.

Demorest, M.E., & Erdman, S.A. (1984). A database management system for the communication profile for the hearing impaired. *Journal of the Academy of Rehabilitative Audiology, 17,* 87-96.

Driskell, J., & Dwyer, D. (1984). Microcomputer videogame based training. *Educational Technology, 24,* 11-17.

Grossman, K.E., Siders, J.A., & Garraway, H.P. (1983). Sign teacher: A microcomputer application for the teaching of sign language. *American Annals of the Deaf, 128,* 577-584.

Harlan, D. (1982). Sequenced inventory of communication development (SICD) system. In J. Fitch (Ed.), *Software register #2: Computer users in speech and hearing (CUSH).* Mobile, Alabama: University of Southern Alabama.

Henoch, M.A. (1985, July). *The use of computer-interactive software in aural rehabilitation.* Paper presented at the Southcentral Regional Conference of the American Speech-Language-Hearing Association, San Antonio, TX.

Hight, R.L. (1981). Lipreader trainer: A computer program for the hearing impaired. In P. Hazan (Ed.), *Proceedings of the Johns Hopkins first national search for applications of personal computing to aid the handicapped* (pp. 4-5). Los Angeles: IEEE Computer Society Press.

Hood, S.B., & Miller, L.R. (1984). Administrative applications for microcomputers. In A.H. Schwartz (Ed.), *The handbook of microcomputer applications in communication disorders* (pp. 219-245). San Diego: College Hill Press.

Jackson, C. (1984). Guidelines for software evaluation. *Journal of the Academy of Rehabilitative Audiology, 17,* 82-86.

Jacobs, M.A. (1975). Programmed self-instruction in speechreading. *Journal of the Academy of Rehabilitative Audiology, 8*(1 & 2), 106-109.

Jacobs, M.A. (1982). Visual communication (speechreading) for the severely and profoundly hearing-impaired young adult. In D.G. Sims, G.G. Walter, & R.L. Whitehead (Eds.), *Deafness and communication: Assessment and training* (pp. 271-295). Baltimore: Williams & Wilkins.

Jerger, J., & Fifer, R. (1984, June). *Rehabilitative aspects of cochlear implant surgery and computer interfacing to chart rehabilitative progress.* Paper presented at the Summer Institute of the Academy of Rehabilitative Audiology, Watts Bar Dam, TN.

Kopra, L.L., Abrahamson, J.E., Dunlop, R.J., & Kopra, M.A. (1985, July). *The use of computer-interactive software in aural rehabilitation.* Paper presented at the Southcentral Regional Conference of the American Speech-Language-Hearing Association, San Antonio, TX.

Kopra, L.L., Dunlop, R.J., & Kopra, M.A. (1984, June). *Computer-assisted instruction in lipreading.* Paper presented at the Summer Institute of the Academy of Rehabilitative Audiology, Watts Bar Dam, TN.

Kopra, L.L., Dunlop, R.J., Kopra, M.A., & Abrahamson, J.E. (1985, January). *Computer-assisted instruction in lipreading with a laser videodisc interactive system.* Paper presented at the computer conference of the American Speech-Language-Hearing Foundation, New Orleans, LA.

Kopra, L.L., Kopra, M.A., Abrahamson, J.E., & Dunlop, R.J. (1985). Computer program for listening training at threshold levels. Unpublished manuscript.

Lewell, J. (1985). Ergonomically speaking. *AV Video, 7*(6), 25, 54.

Lotterman, S.H. (1985a). Audiologic report generator. In *Research and development in the Department of Audiology: Annual report.* Washington, DC: Gallaudet College.

Lotterman, S.H. (1985b). Introduction to audiology: A computer-assisted instruction package. In *Research and development in the Department of Audiology: Annual report.* Washington, DC: Gallaudet College.

Lovece, F. (1984, April) Videodisc hardware. *Electronic Learning,* pp. 60-65.

Magel, M. (1985). The interactive video standoff: Tape vs. disc. *AV Video, 7*(5), 31, 58-59.

McConnell, R. (1983, November). Laserdiscs, pros and cons. In *Proceedings of the Laserdisc Technology Conference held at the Southern Alberta Institute of Technology* (pp. 3-7). Calgary, Alberta, Canada: Alberta Vocational Center and Alberta Laserdisc Committee.

Mills, R., & Thomas, R. (1983). *Word recognition programs* (Computer program). Ann Arbor, MI: Brain Link Software.

Newell, W.J., Sims, D., & Myers, T. (1983). Principles and requisites of computer-assisted interactive video instruction: A sign language lesson. *American Annals of the Deaf, 128,* 662-672.

Parker, W. (1984). Interactive video: Calling the shots. *PC World, 2*(11), 99-108.

Popular Computing. (1984, Mid-Oct Sp. Issue). Trying to predict the future [Interview with eleven individuals involved with computers and education], *Popular Computing, 3*(13), 30-44.

Rushakoff, G.E. (1984a). Clinical applications in communication disorders. In A.H. Schwartz (Ed.), *Handbook of microcomputer applications in communication disorders* (pp. 147-168). San Diego: College Hill Press.

Rushakoff, G.E. (1984b). A clinician's model for the review of speech, language and hearing microcomputer software. *Asha, 26*(8), 43-44.

Rushakoff, G.E. (1984c). *Microcomputer-assisted study partner in anatomy and physiology* [Computer program]. San Diego: College Hill.

Rushakoff, G.E. (1985). Computer technology in the practice of communication sciences and disorders. In *Leadership training in computer technology* (pp. 21-26). Washington, DC: American Speech-Language-Hearing Association.

St. Lawrence, J. (1984, April). The interactive videodisc. Here at last. *Electronic Learning,* pp. 49-51.

Saunders, F., Hill, W., & Simpson, C. (1980). Speech perception via the tactile model: Progress report. In H. Levitt, J. Pickett, & R.A. Houde (Eds.), *Sensory aids for the hearing impaired.* New York: John Wiley & Sons.

Schneider, E.W., & Bennion, J.L. (1981). *Instructional media library: Vol. 16. Videodiscs.* Englewood Cliffs, NJ: Educational Technology Publications.

Schneiderman, M. (1984). Making the case for innovation. *Popular Computing, 3*(13), 88-95.

Shearer, W.M. (1984). Academic and instructional applications for microcomputers. In A.H. Schwartz (Ed.), *Handbook of microcomputer applications in communication disorders* (pp. 193-218). San Diego: College Hill Press.

Sims, D.G. (1978). Visual and auditory training for adults. In J. Katz (Ed.), *Handbook of clinical audiology* (2nd ed, pp. 565-580). Baltimore: Williams & Wilkins.

Sims, D.G. (1984, November). *Speechreading evaluation.* Paper presented at Children's Hospital Symposium on Cochlear Implants, New York, NY.

Sims, D., Scott, L., & Myers, T. (1982). Past, present and future computer-assisted instruction at NTID. *Journal of the Academy of Rehabilitative Audiology, 15,* 103-115.

Sims, D.G., Snell, K., & Clymer, W. (1984, June). *Computer-based interactive videotape communication instruction: Auditory training, speechreading, and sign language.* Paper presented at the Summer Institute of the Academy of Rehabilitative Audiology, Watts Bar Dam, TN.

Sims, D. (1985). Adults with hearing impairment. In J. Katz, (Ed.), *Handbook of clinical audiology,* (3rd ed., p. 1025). Baltimore: Williams & Wilkins.

Sims, D., VonFeldt, J.,Dowaliby F., Hutchinson, K., & Myers, T. (1979). A pilot experiment in computer assisted speechreading instruction utilizing the data analysis video interactive device (DAVID). *American Annals of the Deaf, 124,* 618-623.

Smaldino, J., & Traynor, R. (1984, February). *A systems approach to aural rehabilitation.* Paper presented at the computer conference of the American Speech-Language-Hearing Foundation, Las Vegas, NV.

Utz, P. (1985). More about TV monitors (and still not a word about the Merrimak). *A V Video, 7*(6), 35, 48.

Videodisc Monitor (1985, August). Where are they? Locations and amounts of industrial videodisc players. *Videodisc Monitor,* p. 18.

Walden, B.E., Erdman, S., Montgomery, A.A., & Prosek, R.M. (1981). Some effects of training on speech recognition by hearing-impaired adults. *Journal of Speech and Hearing Research, 24,* 207-216.

Zimmerman, H.R. (1984). *Computerized audiometric programmable simulator (CAPS)* [Computer program]. San Diego: College Hill Press.

APPENDIX A

COMPUTER-TO-VIDEO INTERFACES

The following sources provide computer-to-video (videodisc/videotape) interface cards. Prices are variable ($150 to $2000) as are other options. Authoring languages are provided with most interface boards; some are included in the purchase price. The listing is taken from Parker (1984) and Lovece (1984).

Allen Communications
140 Lakeside Plaza II
5225 Wiley Post Way
Salt Lake City, UT 84116
801/537-7800
System: Apple II, II+, IIe, IBM-PC
Requires RS-232C serial port

Alphatel Systems, Ltd.
Suite 102
11430-168 St.
Edmonton, Alberta, Canada
T5M 3T9
403/451-5761
System: Apple II, II+, IIe

BCD Associates, Inc.
205 Broadway, Tech. Center
7510 N. Broadway Ext.
Oklahoma City, OK 73116
405/843-4574
System: Apple II, II+, IIe, IBM-PC in emulation mode, or any RS-232C serial port computer

Cavri Systems
26 Trumbull St.
New Haven, CT 06511
203/562-4979
System: Apple II, II+, IIe, IBM-PC

Digital Controls
5555 Oakbrook Pkwy. #200
Norcross, GA 30093
800/441-3332
System: IBM-PC
Requirements: RS-232C serial port

GenTech/General Tech Corp.
4101 North St. Joseph Ave.
Evansville, IN 47712
812/423-4200
System: Apple II+, IIe

Minnesota Educational Computer Consortium (MECC)
3490 North Lexington Ave.
St. Paul, MN 55112
612/418-3500
System: Apple II, II+, IIe

New Media Graphics Corp.
279 Cambridge St. #5
Burlington, MA 01803
617/272-8844
Requirements: RS-232C serial port
System: IBM-PC

Symtec, Inc.
15933 West 8 Mile Road
Detroit, MI 48235
313/272-0302
System: Apple II, II+, IIe

Video Vision Associates, Ltd.
7 Waverly Place
Madison, NJ 07940
201/377-0302
System: Apple II, II+, IIe, III w/IIe emulator card

Whitney Educational Services
1777 Borel Place, #416
San Mateo, CA 94402
415/341-5818 or 415/570-7917
System: Apple II, II+, IIe, IBM-PC

APPRENDIX B

SOFTWARE FOR AUDIOLOGICAL APPLICATIONS

1. Computer-Assisted Instruction

Audiometric simulator. (1983). G.J. Glascoe. State College, PA: Parrot Software. $99.50 (Apple II).

Computerized audiometric programmable simulator (CAPS). (1984). H.R. Zimmerman. San Diego: College Hill Press. $295.

DAVID speechreading program (1985). D. Sims & M. Schnieder. Rochester, NY: National Technical Institute for the Deaf. (Public domain software. 30 videotape lessons available at $50 each. Apple IIe and II+. Requires three disk drives, clock, language card, BCD 232 linc

video interface card, and videotape player.)

dB made easy. (1985). D.E. Rose. San Diego: College Hill Press. $65 (Apple II).

Masking: A practical approach. (1985). D.E. Rose. San Diego: College Hill Press. $175 (Apple II).

Microcomputer assisted study partner in anatomy and physiology of the speech and hearing mechanism. (1984). G.E. Rushakoff (Ed.). San Diego: College Hill Press. $450 (Apple II).

Pure tone audiometry simulation. (1985). L.G. Siegel & J. Yanz. San Diego: College Hill Press. $395 (Apple II).

Tympanograms. (1985). D.E. Rose. San Diego: College Hill Press. $99 (Apple II).

Word recognition programs. (1983). R. Mills & R. Thomas. Ann Arbor, MI: Brain Link Software.

2. Data Base

Computer-assisted hearing aid fitting and sales program. Katz, K.R. (Ver. 3.1) (1983). Tucson, AZ: Katz Computer Software. $595 (Apple II).

Hearing aid manager (HAM). (1983). G.J. Glascoe. State College, PA: Parrot Software. $69.50 (Apple II).

Select a hearing aid. (1983). G.J. Glascoe. State College, PA: Parrot Software. $69.50 (Apple II).

Systematic hearing aid prescription (SHAP). (1984). D.E. Moomaw. San Diego: College Hill Press. $300 (Apple IIe and IIc only).

3. Evaluation

Audiologic report generator. (1985). S.H. Lotterman. Washington, DC: Gallaudet College.

Computerized aural rehabilitation. (In preparation). R. Traynor & J. Smaldino. San Diego: College Hill Press. (Apple II).

Planning individualized speech and language intervention programs. (1984). J. Berryman & R. Johnson. Tucson, AZ: Communication Skill Builders.

Program for hearing aid selection and evaluation (PHASE V). (1983). J. Popelka. St. Louis, MO: Central Institute for the Deaf. $250 (Apple II and Hewlett-Packard 85).

SCOR the SSW. (1983). G.J. Glascoe. State College, PA: Parrot Software. $69.50 (Apple II).