Two Augmentative Communication Systems for Speechless Disabled Patients

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Patients may be rendered speechless because of many conditions, including cancer surgery, stroke, cerebral palsy, cervical cord and head trauma, neuromuscular paralysis, and intubation for respiratory failure. These same conditions may also be associated with decreased use of the hands, so that writing and other nonverbal forms of communication are also impaired. Lack of communication can frustrate the patient, the family, and health care personnel; increase the patient's isolation; and lead to poor patient cooperation, thus impeding progress in therapy and producing secondary psychiatric disturbances. Two communication programs that use a Commodore 64 computer are described in this paper. One communication program uses the alphabet and the other is based on the international Morse code. These programs are easy to use and inexpensive to establish, and they accommodate any switching device.

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Hardware Setup

The communication programs we developed require a Commodore 64 personal computer, a Commodore 1530 Datasette or 1541 disk drive, and a television or computer monitor. Any black-and-white or color TV can serve as a suitable monitor. These components should be configured in the manner suggested by the manufacturer. The switching device can vary according to the needs of the patient and the resources available. We initially used a simple microswitch (Radio Shack No. 275-016) embedded in an oral prosthesis. As our patient regained some function of his dominant thumb, an ordinary game joystick with a fire button mounted on the base became preferable. The design of the Atari 2600 joystick is well suited for this purpose, but any other switch would be acceptable as well, including a tridigital dynamic orthosis (Dollfus & Oberle, 1984) or an electrooculomographic switch (an electrooculographic switch requires only vertical eye movement by the patient) (ten Kate & van der Meer, 1983). The chosen switch is connected to the Commodore 64 through joystick control port 2. The switch should be connected to pin 6, which is the fire button, and pin 8, which is grounded with a standard nine-pin connector (e.g., Radio Shack No. 276-1538). Alternatively, any device that brings pin 6 to ground will generate a signal that the system can accept. Thus, a powerful feature of this system is that the decoding program is independent of the switch that is used which allows the patient and therapist complete flexibility.

Software Setup

Both programs are written in Commodore BASIC (Commodore 64 User’s Guide, 1984). The programs are entered in the usual manner. All lines are typed with their statement numbers exactly as listed in Appendixes A and B, followed by a return. REM statements are included to facilitate future program editing. After all lines are entered, but before the program is run for the first time, the program is saved. For example, with the program named MCODE, the save command to a 1541 disk drive is SAVE"@0:MCODE",8. The same command will overwrite an edited version of the program. For the 1530 Datasette, a separate, empty tape is used for each program and the tape is fully rewound. The command is SAVE"MCODE". Once the program is entered, it can be viewed for editing with the command LIST. The control key slowly scrolls the screen, and the run/stop key halts the scroll. Reloading the program from the 1530 Datasette requires only the command LOAD “MCODE”; the 1541 requires the command LOAD "MCODE",8. The 1530 prompts for the play button of the Datasette to be depressed and requires the Commodore key be hit after MCODE is found. After the READY prompt returns, RUN is typed and the return key is hit. The run/stop key or the run/stop and restore keys interrupt the program. If prior programs have been loaded, NEW must always be typed followed by the return key before the new program is loaded to avoid interference of program statements.

Program SPEECH

Program SPEECH (see Appendix A) is essentially a text screen editor that requires only a simple switch closure for control. The screen is divided into two parts. The upper four lines contain a display of the standard alphanumeric character set, routine punctuation, and seven special characters; the lower 18 lines are for text display. A diamond is used as a non-flashing cursor in the text field. There are two operating modes. In the automatic scan mode, each character is serially highlighted by a scanning cursor. Closure of the control circuit with the fire button of a joystick or any other switch transfers the highlighted character to the text screen and returns the cursor to the first position of the display set. In the joystick-directed mode, the user controls the position of the highlighting cursor through joystick motion and transfers the character to the screen by switch closure.

After the program has been loaded and the RUN command entered, the program prompts for the choice of operating mode. If automatic scan is chosen, then a second prompt requests the scan rate. A rate setting of 1 keeps each character highlighted for nearly 2 sec before moving to the next character. The therapist can determine the scan rate by dividing 2 sec by the chosen rate so that, for example, a scan rate of 4 provides about 0.5 sec for each character and a rate of 10 allows 0.2 sec. Once the program is running, the patient assumes complete control with the switch or joystick. Four of the special characters are for text editing. The slash (/) will insert a blank space, the heart character performs a carriage return, and the symbol @ (each) deletes the character before the diamond cursor. The user can clear the text field by choosing the symbol for number (#). To prevent inadvertent erasure, a brief note appears at the bottom of the text field. This note requests that the user confirm by pressing the fire button a second time. If the button is not pressed within the period of indicated countdown, then the text is not erased and editing resumes. The £ character permits the user to change between operating modes or to reset the scan rate. As with the text field erasure, confirmation is requested. If the request is confirmed, then a brief message at the bottom of the text field prompts for a choice of 0 through 9: the 0 indicates a choice of the joystick-directed mode, and 1 through 9 correspond to scan
The sequence of 0 through 9 is then displayed in the bottom left corner of the screen and the user chooses the number desired by depressing the fire button. Except for the last five lines where the message prompts appear, the text field is not erased by this procedure.

It is possible to store the text on a floppy disk as a standard ASCII sequential file if a 1541 disk drive is present. The ASCII file can then be used for many purposes, one of which is to import the file into any standard Commodore word processor and print the text. Another option is to export the ASCII file through a communication program, either as electronic mail to another site or to a non-Commodore computer. Once this is accomplished, the ASCII code can be used as a source program in BASIC or any other programming language or taken into a word processor on that machine. Thus, creation of the ASCII file introduces a large range of options.

In the automatic scan mode, the up arrow (↑) character jumps the scanning cursor to the end of the first line so that the time it takes to scan to later characters is shortened. In the joystick-directed mode, if a black-and-white TV is used as the screen, the character set is not displayed immediately and the user must reveal the set by scanning with the joystick to the right for four lines.

Program MCODE

The MCODE program uses international Morse code and serves as an interpreter of the code, sequentially sending the letters to the screen. Statements 10 to 750 (see Appendix B) contain the program logic and several technical steps to set machine conditions for sound and input. Statements 1000 to 1875 interpret the input. In addition to the complete international Morse code alphabet and decimal sets, the program contains three nonstandard codes: (a) space is coded · · · · · ; (b) a carriage return is coded · · · · ·; and (c) the last letter on the screen can be deleted by depressing the switch for a time longer than a dash. The present program settings provide for a very slow rate of input, which is appropriate for a patient just learning the system. Statement 10 of the program sets the duration of dot and dash as well as the time without input that is interpreted as end of character. It is easy to modify the program to increase or decrease the rate of input. Reduction of the value of the DA variable will create a shorter switch closure time interpreted as a dash; reduction of the value of the DE variable will shorten the closure time interpreted as a delete. Reduction of the value of the BL variable will allow closer spacing of the character sequences; an increase of these values will have the opposite effect. The patient will choose the most comfortable signal durations through trial and error. The switch is automatically activated after the RUN command, and there is no flashing cursor. The character set of the international Morse code is widely available and can be found in most encyclopedias. A copy of the code on a board next to the computer provides simple reference for the patient.

Discussion

Augmentative communication systems help convert a speechless patient's remaining motor activity into intelligible language. The most basic device—a communication board with the letters of the alphabet—is inexpensive but tedious because it requires the observer to remain present while the patient conveys his or her message letter by letter. Word boards and keyboard voice synthesizers with fixed words or brief phrases improve communication speed, but most are limited to a small vocabulary. The introduction of modern electronic technology into the field of augmentative communication has greatly increased the flexibility of speech systems for disabled persons (Barton & Zuckerman, 1988; Gralla, 1987; Lundell, 1985; Weintraub, 1982). Use of symbols instead of words can help to overcome associated language disorders (Leven, 1984). The basic elements of electronic augmentative systems are an input device, an encoder, and a display. Of these, the input element is the most sensitive to the patient's condition. Patients with reasonable control of one or both hands can use a computer keyboard or sophisticated devices that can transmit a variety of cues (Walsh & Westphal, 1986). For those patients without good dexterity of even one hand, simpler switching devices are necessary. For instance, on-off switches activated by any manner of hand or foot movement can be used (Dollfus & Oberle, 1984). For quadriplegic patients, eyelid or forehead movement (ten Kate & van der Meer, 1983), head turning, or shoulder shrugs can be employed. It is also possible to harness lip movement through the use of a lip-activated switch held stable by a bite-block (Netsell, 1985).

The systems that we have described were designed to be inexpensive, easily implemented, and flexible. Because the Commodore 64 is widely available, inexpensive, and adaptable to a standard television set for output, it is attractive for departments with limited financial resources. We have eliminated software costs by providing the complete programs in Appendixes A and B. In addition, the joystick ports are easily accessed and permit completely flexible switch input. The disadvantages of the Commodore 64 are that (a) the system is not portable; (b) Commodore hardware and software must be used for most word processing and printing; and (c) there are fewer pro-
grams for the handicapped written for the Commodore than for IBM- or Apple-compatible computers.

Of the three communication options offered within these two programs, program SPEECH, when operating in the automatic scan mode, is the least demanding for the patient. Training time is usually less than 10 min, and the patient gains communication almost immediately. The patient’s closure switch permits complete control of the program once it is started, thus making this program preferable for severely disabled persons. For example, quadriplegic persons can operate the program with an ocular or oral switch. The primary limitation of the automatic scan mode is that it is slow, because characters are sequentially accessed. Use of the special character to skip the first third of the alphabet helps to minimize this problem. The minimal learning time and simplicity make this mode attractive for acutely ill but alert patients who require ventilator support and whose arm movement is limited by catheters or casts.

Program SPEECH, when operating in the joystick-directed mode, permits greater speed and accuracy but requires more control of the arm and hand. This program would have application for patients with strokes who have temporarily or permanently lost vocalization and the use of the dominant hand. Scanning is permitted in all four directions, which greatly increases the speed of accessing characters. Although we describe the alternate mode of program SPEECH as the joystick-directed mode and actually used a joystick for program development, many disabled patients may prefer a simple switching device with three large surfaces that close switches when depressed. Two surfaces would provide directional control of the cursor while the third would substitute for the fire button to send the letter to the text screen. We have recently employed this type of device for a 35-year-old man with hypoplasia of both arms but relatively good control of his legs. Use of a bidirectional device such as this limits scanning to right and left only. The therapist can permanently store either mode of program SPEECH with the 1541 disk drive by calling a subroutine that creates an ASCII disk file.

Program SPEECH, whether operating in the automatic or joystick-directed scanning mode, requires that the patient have relatively intact cognitive function, including a good attention span, intact language function, and the ability to follow directions. In addition, the patient must be highly motivated to communicate. This latter feature is crucial and is exemplified by two patients that we worked with. In one patient who was minimally disabled, post-stroke depression interfered with the patient’s use of the program SPEECH system, even after learning had been attained and ample motor and language skills remained. On the other hand, a severely disabled but highly motivated patient with arm hypoplasia avidly dedicated himself to achieving the first expressive communication of his life. This patient remains dependent on a helper to turn the system on and off and to enter the program from disk and start it running, but once started, the patient is in complete control of the system.

Program MCODE is the most difficult to learn, but once learned, probably permits the greatest speed of communication, so that chronically impaired patients may prefer this program. Unlike program SPEECH, program MCODE does not require intact vision, making it suitable for patients with visual impairment. Sophisticated systems using Morse code have been created (Shannon, Staewen, Miller, & Cohen, 1981). Program MCODE can be used as a training program or to test the applicability of more complicated systems for a particular patient.

Appendix A
Program SPEECH

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1 PRINT*•, 4 2 INPUT JOYSTICK (J) OR SCAN (S) REM
3 IF J=2 THEN 6 4 PRINT SETS UP THE NUMERIC CHARACTER SET
5 IF S=2 THEN 6 6 YM•
7 INPUT SCAN SPEED 1=200, 5:55
8 Y•
9 PRINT* 10 SUBROUTINE 2000 DELETES THE LAST CHARACTER
3000 RETURN
10 RETURN
3002 RETURN
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References


