ABSTRACT
        The paper explores the spectrum of communication
needs of physically handicapped individuals, focusing on six basic
areas: (1) conversation, (2) messaging, (3) portable writing needs,
(4) workstation writing, (5) access to computers and information
processing equipment, and (6) access to controls and control panels
needed for daily living or employment. The strengths and weaknesses
of current technology in meeting individuals' needs in each of these
areas are examined. (JDD)

ED289313

NON-CONVERSATIONAL COMMUNICATION TECHNOLOGY
NEEDS OF INDIVIDUALS WITH HANDICAPS

Vanderheiden, G.C.

Trace Research and Development Center
on Communication, Control, and Computer
Access for Handicapped Individuals
University of Wisconsin-Madison

Waisman Center/1500 Highland Avenue   Madison, Wisconsin 53705-2280   (608)262-6966 TDD: (608)263-5408

2

NON-CONVERSATIONAL COMMUNICATION TECHNOLOGY NEEDS OF INDIVIDUALS WITH HANDICAPS

by Gregg Vanderheiden

Advances in technology, particularly in the area of speech synthesis, have brought recent focus and attention to the area of augmentative communication techniques for severely speech impaired individuals. Continual advances in both the miniaturization and the cost reduction of technologies have furthered the excitement over conversational aids using these high technologies. However, a careful study of the total communication needs of these individuals indicates that conversation may not be the communication need most in need of technological assistance and in the best position to benefit from such assistance at this time. Moreover, the focus on the conversation need has resulted in other communication needs of these individuals going unnoticed or unmet, with severely detrimental and long-term effects.

This article explores the different communication needs of physically handicapped individuals, both now and in the near future. It also explores the strengths and weaknesses of current technology in meeting these needs. Finally, some of the directions technology is taking and the implications of this in meeting the various communication needs of physically handicapped individuals will be discussed.

A Spectrum of Communication Needs

Individuals who are severely physically handicapped are often unable to control their oral-respiratory musculature sufficiently to be able to speak. In most cases, however, the individuals who are so disabled that they are unable to speak are also unable to write and use other communication and control techniques or devices effectively or at all.

Mr. Vanderheiden is director of the Trace Research and Development Center for the severely communicatively handicapped, University of Wisconsin—Madison.

Thus, these individuals are not only unable to converse, but also unable to write, take notes, leave messages, or access computers or devices within their environments.

To date, the focus has been placed on the conversational needs of these individuals. This is in part because there is a discipline; speech pathology; focused on the conversational problem, but no similar discipline or focus for the other communication modes. Teachers are in charge of providing instruction in the academic writing skills, but this does not address the physical act of writing. Occupational therapists are responsible for providing restoration of physical skill, but when physical and linguistic processes must be combined in order to solve an individual's needs, the need tends to fall into the gap between disciplines.

As a result, individuals who have speech but who are totally unable to write are not perceived as having a communication handicap, even though it is doubtful that they can receive anything approaching an adequate education without the ability to communicate in written form. Imagine sending any child to school without pencil and paper, and with the instructions "Don't worry about writing anything down or doing any homework, just listen carefully in class." More evidence of this narrow focus on conversational communication he found in the large numbers of individuals who, unable to speak or write, are provided with electronic aids which have only a voice output, and have no provision at all for written communication. In many cases, these aids can cost thousands of dollars, thus precluding the provision of a second aid to meet the individual's writing needs.

Let's take a look, then, at the full spectrum of communication needs which must be met in order to allow for normal development of the personal and cognitive skills of physically handicapped children (and the full utilization of those same skills in physically handicapped adults).

Although these communication needs are in many ways a continuum, and can be divided at many points, for the purposes of this discussion I will be dividing these needs into six basic areas. Not all of these areas would be considered equally important; they are also not equally addressable by technology today. They may be thought of, however, as six legs on a very long table. Providing only one or two of them will not be very helpful functionally to the individual who requires all of them. Even the absence of one can result in severe problems. The six areas are:

1. Conversation (those quick and temporal communication and socialization needs we usually meet with speech)
2. Messaging (the delayed presentation of a message prepared earlier)
3. Portable writing needs (those needs generally met with a pencil and paper, but which could not be met by electric typewriter located only at home or only at work; i.e., 95% of all of our writing)
4. Workstation writing (that work which could be done on a single large stationary writing instrument)
5. Access to computers and information processing equipment
6. Access to controls and control panels needed for daily living or employment.

Conversation

This is the most commonly thought of need when communication is first mentioned. In fact, in many cases, it is treated as synonymous with "communication."

When looking at conversational needs, most of the focus has been on providing an individual with a "voice." In fact, it turns out that rate is much more important than form for conversation, that is, whether it is visual or vocal. Normal conversation takes place at the rate of about 180 words per minute

"... but it is extremely difficult if not impossible to carry on a conversation in the usual sense of the word ... if one of the conversational parties is communicating at 130 wpm and the other is communicating at 2–8 wpm."

(wpm). Conversations can be held at slower rates, but it is extremely difficult if not impossible to carry on a conversation in the usual sense of the word if the communication rate is limited to 2–8 wpm. This is especially true if one of the conversational parties is communicating at 180 wpm and the other is communication at 2–8 wpm. Communication and interaction can and does take place. In general, however, all of the rules of normal conversation are violated, and interactions are generally short, dominated by one party, and highly frustrating. This is true whether the form of communication is spoken, written, or visual.

When the rates are more reasonable, however, conversations can and do take place routinely in a wide variety of forms. Speech is by far the most common, and fastest, mode of conversation. Conversation through signs and gestures, however, is also very common and very effective. Similarly, conversations using typed mediums, TDDs, and other visual and printed forms routinely take place.

The lure of "voice" is so powerful, however, that most people identify "voice" with "language," and make the erroneous assumption that if they can provide their client with a voice of some type, then the client will be able to "talk" and "converse." In fact, although voice output is very powerful and highly desirable in itself, communication rate is a more important factor than form in providing an individual with an effective means of conversational communication. More on this later.

Messaging

Messaging is a technique which normal vocal individuals only use occasionally. As a result, it would usually be covered under portable written communication (below). When communication is very slow, however, as with many of the non-vocal or severely speech impaired individuals, messaging is used much more extensively in an attempt to meet many of the needs otherwise handled through conversation. It is sometimes assumed that a slow communicator can carry on a conversation by simply preparing his message in advance

on his own time, and presenting it to the message receiver when it is completed. This, however, only suffices for the first sentence of the conversation. As soon as the second party responds, the first party is left having to communicate at his real time rate, which may be only 2–3 wpm. Thus what results is usually not a "conversation," but rather an introduction of the topic by the handicapped individual, followed by an interaction dominated by the second party. Messaging is still an effective partial solution, and can also be used by handicapped individuals to later prepare rebuttals on their own time to precisely express their thoughts. This is best handled, however, if the individual's communication aid has some form of printed output.

Portable Writing

Of crucial importance to any physically handicapped child with near or above normal intelligence is the ability to write. No normal child could receive an adequate education if he did not do any written exercises, homework, or independent work as a part of his educational program. Similarly, it is essential that the physically handicapped child be provided with a "pencil and paper" or the equivalent if he/she is to be able to have a chance at a meaningful education. Also, just as a typewriter at home could not provide the normal child with the necessary writing instruments for taking notes, doing in-school work, or carrying out mathematical manipulations, a typewriter, even one equipped with special keyguards, etc., cannot meet the writing needs of the physically handicapped individual. Nor can a single typewriter shared among a number of handicapped individuals meet the writing needs of these individuals, any more than a pencil or two shared among any class of children meets their writing needs.

Thus, in order to provide the physically handicapped individual with a reasonable chance for education or employment, it is essential that he/she be provided with "pencil and paper"—a personal portable means for writing which they are able to keep with them at all times and use for notes, work, etc., as

they move about in their school, work, and home environments. This means of writing must also be provided to these individuals at the same time that the non-disabled child is provided with his pencil and paper (or before).

Rate is very important here as well. Providing the individual with a means of writing which is five to ten times slower than that of his/her peers will only guarantee that he is unable to keep up with his non-handicapped peers. One day's work every week or two is unacceptable in education or employment.

Workstation Needs

The workstation writing needs are similar to the portable writing needs. They are separated here in that some large writing tasks might be handled on a stationary writing system. At least at the present time, it is possible to provide more power and better display options in stationary systems than are currently possible in portable systems. This is changing rapidly, however.

The other reason for establishing the stationary written category is to differentiate those things which could be handled in stationary writing situations from those writing needs which *must* be met by a portable aid.

Access to Computers and Information Processing Systems

This is a need which is less obvious to those of us who came up through an educational system devoid of computers, and whose workplaces are untouched or barely touched by computers today. The use of computers in both education and employment, however, is increasing at an extremely rapid rate, and it is doubtful that very many of our children will be able to make it through school if they are unable to access and use the computers which will be available to their classmates. Again, this will be particularly true of those physically handicapped individuals who wish to capitalize on developing their mind to compensate for their lower physical skills In employment situations, the inability to access and use computers will be an even greater handicap, again especially for those individuals who will be making

4

their livings using their minds. Finally, the ability to use computers can greatly facilitate many activities which are currently very difficult for physically handicapped individuals to accomplish. As the business world and society in general moves more and more toward electronic information processing, the physical manipulation problems of physically handicapped individuals will decrease. Their handicaps will decrease therefore as well, but only if they are able to fully access these information and data processing systems. Again, this is a communication question, and is very similar to the problem faced by the individual in attempting to carry out a conversation with another person (e.g., both involve the transfer of information which could be handled through a special keyboard or interface of some type). Moreover, the techniques, interfaces, and aids necessary to provide this interface to the computer are extremely similar if not identical to those required for conversation.

Access to Controls and Control Panels Needed for Daily Living

This final area deals with the need for individuals to communicate with or control non-keyboard devices. This includes control panels as well as general environmental device control. In the past, this has always been treated as a separate area. With the advent of computers and information processing systems, however, the idea of control of various items within the environment via a general communication and control system is rapidly evolving. It is important that this evolution be incorporated directly into the communication and control systems for physically handicapped individuals. Eventually, as robotics also becomes realizable, this will extend to communication with and control of robots or other manipulators. At that point, the equivalency of communication and control becomes very obvious. No environmental control or robotics advances will be of any use to an individual who is unable to communicate with or control these devices. Moreover, the exact same principles and problems as well as solutions for the general communication needs described above will apply in these applications.

Overview of Communication Needs

As can be seen from the above discussion, the communication/control problems faced by handicapped individuals take many forms, but all basically come down to providing the individual with an effective means to transfer information to a communication/control device. Once the individual is able to commu-

nicate effectively with this device, different output forms (voice, written, electronic, etc.) can be connected to it to allow him/her to meet the various types of communication needs.

In the past, these various needs have been addressed individually with a single aid prescribed to meet a single need. Due to the high cost of the aids, however, this generally meant that only one of the needs was addressed, usually conversation. In most cases, this was unnecessary, and detrimental to the individual in the long run. Properly designed aids can easily address many or all of the above needs, at little or no increased cost over a single-function aid. This is due primarily to the fact that all of the communication needs discussed above share many of the same components. These components include:

a. a user interface which is optimized to the individual's specific residual capabilities.

b. methods for accelerating the effective rate of information transfer (levels, word vocabularies, abbreviation expansion, etc.).

c. a portable package and power source.

d. visual output or selection displays.

e. a standard RS232 output port.

Only the specific output forms to meet the various communication needs differ.

In looking at the overall communication needs of handicapped individuals and considering augmentative aids, therefore, it is important to understand and keep in mind all of the need areas, in order to provide the optimum overall approach for the individual and to prevent restriction of the individual's overall options by premature prescription of a single-function device. It is also important to understand the current potentials and limitations of technology in meeting the above needs.

A Review of Current Technology

Before discussing the abilities and limitations of current technology, it is important to note that these technologies are changing very rapidly. The reader is therefore urged to note the date that this article was published, and to bear this in mind when reviewing the following comments. Whereas many of the principles discussed in the article may remain true over a reasonable period of time, the specifics of the assessment of technology which follows is specific to Spring, 1983.

Conversation: Currently, technology is unable to address this area very well at all. The primary reason for this is the

lack of technologies to really provide the rates necessary for effective conversation. The average individual on an augmentative communication aid at the present time is communicating at a rate of approximately 3–5 wpm. With better prescription and therapies, it is possible to increase this figure to perhaps 10–15 wpm. This is still an extremely long way from the 180 wpm rate of normal conversation. Adding voice synthesizers to these aids does nothing to increase the rate of communication. In fact, the fastest mechanism for carrying on a conversation or interaction at the present time is to use a manual type of communication (manual scanning or manual pointing board), and allow the message receiver to construct sentences and concepts from cues given by the non-vocal individual. A single letter or two is usually sufficient cue for the receiver to guess a word, and two or three words in a sentence is frequently all that is required to accurately guess the entire sentence. By proceeding in this fashion, it is possible to communicate at a rate which is perhaps 5–8 times faster than the rate at which the individual would normally be able to communicate. Moreover, this type of anticipation and assistance is not possible with current technological communication aids; nor is it probable that these rates can be matched by such aids in the near future. Very advanced forms of artificial intelligence which allow semantic reconstruction based upon context and limited cues from the handicapped individual will be required. We are only now beginning to scratch the surface of this area.

For a very small percentage of our fastest individuals, some new techniques and the effective use of level systems may provide communication rates which begin to approach the realm of normal conversational rates. For the vast majority of individuals, however, non-automated communication aids will remain the fastest methods for conversation. A number of our clients with automated communication boards, for example, turn off the aids, and use them as manual pointing boards in general conversation, turning the aid on only when they are with a stranger unfamiliar with the communication process or if they are with an uncooperative communicator who interrupts or will not let them finish their thoughts.

Manual communication boards, however, cannot by themselves meet the conversation needs of these individuals. Manual boards are often ambiguous, require that message receivers know how to use them, require 100 percent atten-

tion of the second person, do not allow interjection or quick standard conversational phrases, and do not allow for private or independent revision or extension of the vocabulary and phrases of the boards by the users. Thus, although manual boards may currently be the most efficient approach, they are not always effective or sufficient when used alone.

In short, present technology is only marginally able to address the conversation needs, even when synthetic speech is provided. Yet the potential for technological assistance to conversation is great. The best approach at the present time therefore, appears to be the use of a manual communication aid in conjunction with an electronic communication aid which is able to address the conversation, writing, and computer access needs of the user.

Messaging: Current technologies are very good to excellent in meeting this communication need, particularly if they have some form of printout. Aids which have sufficient memory can also be used in this fashion with only a visual or voice output. Without a printout,

however, many of the normal messaging uses are eliminated, and the aid is limited to functioning as a "conversation starter." Fortunately, the advent of pocket computers and printing calculators is bringing the cost of miniature printers down, and making the provision of portable printed output much easier than it was in even the recent past.

Portable Writing: In order to provide the functions of pencil and paper, an aid needs to have both a visual correctable display and some type of printed output. Moreover, the display should be a multiple-line display rather than a single-line display. This is especially important for younger individuals who will be using the aid to develop their basic writing and math skills. The ability to have at least four lines of display, so that the individual can put an addition or other math problem on the display and move around to solve it is important to the development of basic math concepts, especially if the individual is to be integrated with other students in a traditional math instruction curriculum. Trying to add two numbers written side by side (e.g., "345 + 694 –

?"), as would be required on a single line display, is very difficult, especially for children just developing math skills.

Today's technologies are beginning to address these needs fairly well. The recent announcements of portable microcomputers with multiple line displays and built-in printers not only provides the basis for a direct solution for some individuals (who can use keyboards) but also makes the component parts available for inclusion in specially designed communication/control aids for more severely physically handicapped individuals.

With regard to rate, the technology is also able to address this area better than the area of conversation. This is mostly because able-bodied individuals only write at about 30–35 words per minute (as compared to 180 wpm for conversation). As a result, the individuals communicating at the same 5–10 wpm rates are now working only one-third the rate of their normal counterparts. With some newer techniques which can increase the individual's rate to between 200% and 300% of straight typing, these individuals' rates can be increased to about the

REHABILITATION **WORLD**

The U.S. Journal of International Rehabilitation News and Information

Rehabilitation/WORLD is a quarterly journal designed to disseminate topical and relevant international rehabilitation information to the U.S. rehabilitation community. Rehabilitation/WORLD is published by Rehabilitation International USA (RIUSA), a non-profit voluntary organization dedicated to the advancement of service to the disabled worldwide. It is distributed to individual members of RIUSA, institutional subscribers in the United States, as well as individual and institutional subscribers overseas. Current rates are as follows:

In the United States		International Subscriber	
Individual Member	$25.00	Individual	$35.00
Organizational Subscriber in USA		Non-Profit	$45.00
Non-Profit	$35.00	Commercial	$60.00
Commercial	$50.00		

Orders should be sent to: Circulation Dept., Rehabilitation/WORLD, 1123 Broadway, New York, N.Y. 10010. Please enclose check made payable to RIUSA in U.S. currency with order. Our telephone number is (212) 741-5169.

Reproduction of material published in Rehabilitation/WORLD, in full or in part is prohibited unless permission is granted by the publisher.

Views expressed in published articles are those of the authors and do not necessarily coincide with the official policy of Rehabilitation International USA. Editorial mention or description of a product or service does not imply endorsement by RIUSA.
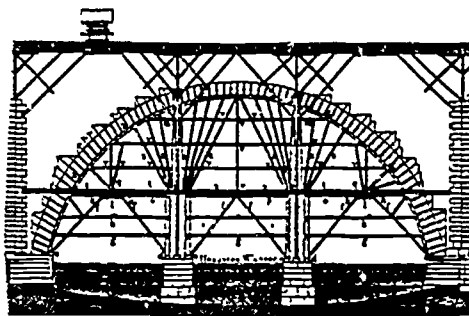
Copyright © 1983 by Rehabilitation International USA.

normal rate of handwriting. For the more severely involved individuals, the rates may not reach this handwriting range. Whatever their rate of communication, however, it will be about six times closer to the writing rate of their peers than it will be to the conversation rate of their peers. This is particularly good news for such activities as education and some types of employment, where performance is more a function of thinking and writing than of conversation.

Stationary Writing Systems: With the advent of microcomputers, this area has also been fairly well addressed. Previously, this was the only writing area that was well addressed, due to the limited number of portable writing systems available. Because of the increased power available in stationary systems, there is still a tendency to secure stationary systems for individuals who in fact have greater need for portable systems. In general, the portable system is needed first, with a stationary system being provided for those individuals with sufficient writing needs that they require both. Eventually, it is likely that the portable systems will become so powerful that the stationary systems will become unnecessary, or will take the form of expansions to the portable systems. This transition can be seen as technically feasible in as few as 3–5 years, but will probably take longer than that to realize, due to delays in the development of appropriate specialized software.

Access to Computers and Information Processing Systems: At the present time, technological approaches to solve this problem have already been defined and described. Through the use of *keyboard emulators,* it is possible to allow individuals with disabilities to use their personal communication/writing systems to control any computer. The keyboard emulators are small modules which are installed in a standard computer. Thereafter, individuals whose communication aids have RS232 serial connectors (available on most computers either as standard or optional equipment) can connect to the keyboard emulator and use the computer. The keyboard emulator feeds the characters and words sent to it into the computer in such a way that the computer cannot tell that the handicapped individual is not typing in the normal fashion on the computer's keyboard. In this way, the handicapped individual can use whatever communication/control interface he/she requires and still operate the computer and use it with all of the standard software being used by his/her

peers. The keyboard emulators, however, must be designed specifically for the different brands and models of computers; a keyboard emulator designed for an Apple II Plus will not function with an IBM Personal Computer, nor even with an Apple IIe.

At the present time, keyboard emulators are only available for one or two of the most popular microcomputers. A major program has been mounted at the Trace R&D Center to coordinate the development of keyboard emulators for all major computers and to provide information on the availability of these emulators as they are completed.

As a result, this area need not be a long-term problem, as long as

1) communication aids all have an RS232 serial connector on them.

2) schools (or the individuals themselves) see that the computers which they need to operate each have keyboard emulators installed in them.

Access to Control Panels and Other Devices: As with the area of conversation, the current aids are only marginal in addressing this area. Newer aids and control systems, however, are incorporating the ability to accept commands over an RS232 serial link. As a result, compatability between the individual's communication/control aid and various control systems is seen as steadily increasing over the next short while. For those devices and controls in the environment which are designed to be operated by normal individuals, special actuators or keyboard emulators may again be required. There will probably be slower in coming than the computer keyboard emulators. When they do appear, however, they will generally also use the serial link for control. At the present time, the best guess for the communication format would be RS232 serial.

As robotics become practical a whole new world will open up. Quick and effective communication links between the handicapped individual and the robotic system(s) will be essential. The rate at which the robot will be able to execute commands, especially novel activities, for the individual will be a direct func-

tion of the individual's communication rate with the system. Eventually, it will be possible to have a robotic manipulator which could carry out many or all of the manipulative functions required by the physically handicapped individual. This type of general purpose, mobile, multi-function robot, however, is quite a ways away. When and as it becomes reality, however, it will be the person's communication and control system which will need to provide a rapid and efficient communication channel to the robot.

Summary

The communication needs of handicapped individuals go far beyond conversation. For a physically handicapped individual, they also extend to written communication and computer access needs, which must be met if the individual is to receive an adequate education and develop or utilize his/her cognitive capabilities in a productive fashion. The same communication system may also be utilized to communicate with or control other devices within the individual's environment.

At the present time, technology can best address the written and computer access needs of the handicapped individual. Technology's ability to address the conversational needs is much more limited. This is primarily due to the fact that the conversational needs require a much higher rate in order to achieve a parity with non-handicapped individuals than is required to achieve parity with written communication needs (180 wpm versus 35 wpm, respectively). At the present time, the conversational needs are often best met through the use of communication strategies and a manual communication system, backed up by a portable writing/conversation aid which may include a voice output.

As our understanding of the communication process for severely rate-limited communicators is better understood, we may be able to take further advantage of some of the opportunities technology offers us and make better inroads into all of the areas of communication impairment. Conversation will always remain a very difficult area to address, however, and the physical information transfer rates of these individuals will always be frustratingly limited. As a result, I expect that the major gains to be made in this area will be a direct result of better understanding of the communication process and strategies for better interaction which may then be implemented in the technologies rather than in the advances of the technologies themselves.