SENSORY AIDS

Edited by

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Fabrication of Obstacle Detectors for the Blind

Bionic Instruments, Inc., Bala Cynwyd, Pa. 19004
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Several modifications to the canes were discussed in the last issue (BPR 10-15). All of these have now been carried out, and the canes are scheduled to be in the hands of the mobility trainers at Hines VAH and the Menlo Park Div. of Palo Alto VAH by July 15, 1971.

During this period, several meetings of Dr. Nye's panel on cane evaluation were participated in by Bionic's personnel and, as a result, some further modifications were made in the cane, including the addition of a running time meter to measure cane usage.

Work is also proceeding toward the development of the next (C-5) model, which will incorporate the modifications that have been made to the C-4 and will also incorporate further design changes to reduce the cane's weight and its cost of manufacture.

Research on Audible Outputs of Reading Machines for the Blind

Haskins Laboratories, Inc., New Haven, Conn. 06510
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The goal of research on reading machines for the blind at Haskins Laboratories is to produce by machine methods an output of clear, audible English from an input of ordinary printed text. The core problem—generating acceptable speech from phonetic spellings—seems very near a successful solution through synthesis-by-rule methods. There is still much to be done by way of evaluating and improving the synthetic speech, but the research can now turn to some of the other problems involved in setting up a complete Reading Service Center for the blind. Thus, the present emphasis is on user tests of speech synthesized by rule, improvements in the rules (and so of the speech), and automation of the entire speech-generating process.

Evaluation by Blind Users

An article in the "Highlights of Other VA Research Programs" in BPR 10-15 described the completion of user trials with Compiled Speech (another kind of spoken output in which sentences are constructed from single pre-recorded words). Preliminary tests were reported, also, comparing Synthetic Speech with Compiled Speech, and indicating that Synthetic Speech was much preferred. The present report deals exclusively with speech that has been synthesized from phonetic spellings by various combinations of rules for synthesis; in all cases, the major part of the conversion and the generation of the tape recordings has been done by computer.

Some further testing has been done with veterans attending the Eastern Blind Rehabilitation Center, Veterans Administration Hospital, West Haven, Connecticut, with results similar to those already reported. In addition, a Committee on Blind Students at the University of Connecticut has become interested in developing a reading center for blind students that will make use of the methods developed at Haskins Laboratories. The University has assigned a member of the faculty to help in evaluating the synthetic speech, and has provided a student assistant to help in generating additional recordings for this purpose. This permits sample chapters from textbook assignments to be prepared during the summer of 1972. Hence, the user evaluation program is moving ahead vigorously, with present emphasis on accumulating recorded materials for student use, starting in September 1971.

Automating Text Preparation

The preparation of synthetic-speech recordings for user evaluation is, at present, a rather slow process since the printed text must be typed into the computer in phonetic form, and sentence stress and intonation marks must be supplied by the typist. Earlier Bulletins of Prosthetics Research have carried accounts of the phonetic input system, based on a keyboard plus storage oscilloscope coupled directly to the computer.

Recent improvements in the phonetic input facility have been of two kinds. First, the editing capability has been expanded and streamlined. This allows the operator to make changes in the phonetic text both quickly and efficiently. The modified text can be synthesized immediately in order to evaluate any changes that have been made. A second major change pertains to the recording of long passages of text. Until quite recently, the task of producing an audio tape with synthesized text involved much laborious hand-editing. This process has been made automatic; i.e., audio tapes are produced under computer control in a form that is suitable for listening and evaluation with little or no further editing.

Improving the Naturalness of Synthetic Speech

Veterans and students who have listened to synthetic speech often report that it has an "accent," but that it is completely intelligible after the first few sentences. Some texts require attentive listening, and some of the listeners are not sure that the synthetic speech will be easy to listen to for long, unbroken periods of time. Many others find the speech fascinating and fun, and say that even human readers cannot be listened to indefinitely. Clearly, though, improvements in naturalness can and should be made. Work along this line has been directed partly to the phonetic details of the synthesis-by-rule program itself, and partly to extensions of the rules that will mechanize the remaining stages of the speech-generating process.

Modification of the synthesis-by-rule program has concentrated on the details of the allophone tables, and on the application of rules for intonation. Improvements have been made in the acoustic specification of duration and amplitude for stop consonants, clusters of consonants in diphthongs with various stresses, and in modulating the intonation over a less extreme range than before.

Rules have been developed for assigning and modifying word stress in sentences. It is a happy fact that English word stress is essentially stable, even when words appear in sentence context, though the acoustic realization of stress has to be modified to take account of word sequences, word location in breath group, and sentence intonation. Plain and sparse rules for stress modification have been applied to several thousand words of text, yielding speech that departs only rarely from expected rhythms and phrasing. A number of stress problems remain, some of them due to the multiple grammatical usage that is possible for many English words.

Rules for assigning pauses within sentences have been developed also. These depend in part on punctuation, and in part on the number of words in a string and their syntactic functions. (The original rules for synthesis [fully computerized] were quite successful in realizing stresses and pauses when the input phonetic string was suitably marked by the human typist. The objective of the present rules is to develop algorithms [for later conversion to computer programs] that will automate the marking process.)

Automating a Pronouncing Dictionary

A major step in the conversion of printed English into spoken English is the derivation of the phonetic string on which the rules for synthesis will operate: the spelled form of the word must be converted to its pronounced form in phonetic symbols, and to information about its normal syntactic function (s), for use in those rules that assign stress and pause. This part of the problem is being solved by the use of a

comprehensive pronouncing dictionary with syntactic annotations. A dictionary of this kind has been made available through the kind cooperation of the Speech Communications Research Laboratory; some parts of it are already in hand, and the remainder is expected by the end of the summer.

The total dictionary (as received) will contain on the order of half-a-million entries. It corresponds in coverage to the ordinary collegiate dictionary, but has many more entries, since all inflected forms of the words are entered explicitly. Thus, in addition to such normal nouns as *cat,* there are also *cats, cat's,* and *cats'*. Similarly for verbs, there are such entries as *walk, walks, walked* and *walking.* The dictionary also contains separate pronunciations for different dialects and grammatical categories. Many of these variants are not wanted in a dictionary for the projected Reading Service Center; hence, there is a substantial task involved, not only in programing for normal uses of the dictionary, but also in developing algorithms to delete the unwanted material. A substantial part of the "editing" has been done, and revised versions are being prepared for the portions of the dictionary that are in hand. It now appears that the dictionary, in final form for reading machine use, will fit comfortably onto the four disks that are a part of the Laboratories' computer installation; i.e., the entire dictionary will be available for fast random search.

Planning for a Reading Service Center

The interest and cooperation of the University of Connecticut in connection with its own program for blind students make it feasible to plan for the establishment of a Reading Service Center at the University, probably as an extension of the University's present library services to blind students. A schedule has been set for an initial trial period during which the feasibility of such a Center will be fully assessed and equipment needs and budgets for the Center's implementation will be developed. Plans for the trial period call for substantial quantities of synthetic speech to be synthesized at Haskins Laboratories during the 1971-72 academic year. The text will be drawn from the blind students' normal reading assignments. The amount of recorded material that can be provided during the final months of 1971 will be limited by the time required to type phonetic strings into the computer. By early 1972, the automated dictionary should be operating. Any typist can then use a conventional Selectric typewriter to prepare the input text in machine-readable form; thus, the amount of material available for evaluation during the second semester should be very substantial, allowing a thorough evaluation of the utility of the projected Reading Center. During the same period—assuming that the user tests are progressing toward an encouraging conclusion—planning and engineering studies will be made

to determine the type and cost of computer and optical character recognition equipment that will be needed for a full-scale Reading Service Center. The objective of the first phase is to have, by mid-1972, all the necessary data for a policy decision on whether or not to proceed with the implementation of a Center. The user trials and equipment planning for a Center for blind university students is, of course, directly applicable to decisions about a Reading Service Center for blind veterans.

The Development and Evaluation of a Personal Reading Machine for the Blind

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For progress during this report period see "Abstract of Summary Report on the Development of a Reading Machine for the Blind" appearing elsewhere in this issue of the Bulletin.

Reading and Mobility Aids for the Blind, Centrally Directed Clinical Application Program

Central Rehabilitation Section for Visually Impaired and Blinded Veterans, VA Hospital, Hines, Ill. 60141
John D. Malamazian and James J. Whitehead

For over a year the Blind Rehabilitation Section has actively been engaged in research and evaluation of several sensory aids, concentrating primarily on the C-4 Laser Typhlocane. Leicester W. Farmer and James J. Whitehead, Orientation and Mobility Specialists, have been formally designated to conduct research on the Lindsay Russell Pathsounder and Kay Binaural Ultrasonic Sensory Aid in addition to the Laser Cane project.

Previous projects by the team of Farmer and Whitehead have included blindfolded work with the C-4 Laser Typhlocane and modified versions of the C-4 model, in laboratory settings and in various travel environments, learning to best utilize the device and to develop teaching guidelines. Subsequent work involved several O & M Specialists on the Hines Staff being briefly exposed to the device for first impression feedback and professional opinions concerning the potential utility of the device. The results of this brief exposure with the first C-4 models were mixed and inconclusive.

Currently, a blinded staff member is being trained with the newest version of the C-4 Laser Typhlocane and has completed approximately half of his training with encouraging results thus far.

In February 1971, the Advisory Panel for the Preliminary Evaluation of the C-4 Laser Typhlocane was formed by the Subcommittee on Sensory Aids of the Committee on Prosthetics Research and Development,

National Academy of Sciences-National Research Council, under the chairmanship of Dr. Patrick W. Nye. The panel was composed of members of the Subcommittee and in part by four Orientation and Mobility Specialists from Hines, Illinois, and VAH Palo Alto, California, who are already involved in research with the C-4 Laser Typhlocane. Four monthly meetings alternately held at VAH Hines and VAH Palo Alto were planned and supported, in part, by the NAS-NRC and the VA. The purpose of the panel is to review mobility aid evaluation literature, create new evaluation techniques and measurements, and design a preliminary evaluation protocol for the C-4 Laser Typhlocane. The panel has developed a tentative protocol calling for a joint 5-week training and evaluation course at VAH Hines and VAH Palo Alto involving eight totally blinded veterans. The training course will be followed by an extensive followup program in the veteran's own local home community. The course was given at each VA facility during the month of August and the first week in September 1971.

Mr. Farmer attended a 4 weeks' "Instructional Course on the Binaural Ultrasonic Sensory Aid" for O & M Specialists at Boston College, Division of Special Education, Chestnut Hill, Massachusetts. The course was held from April 12 to May 7, 1971. Upon his return to VAH Hines, Illinois, Mr. Farmer began training one of the blind staff members in the Blind Rehabilitation Section. This trainee is one of 10 blind persons who will be trained to use the Binaural Ultrasonic Sensory Spectacles at VAH Hines as part of an international effort, in conjunction with other O & M Specialists, to evaluate the binaural aid during 1971 and 1972. Mr. Whitehead will attend the second course on the Binaural Ultrasonic Spectacles for O & M Specialists which will be held at Western Michigan University, Kalamazoo, Michigan, and will participate in the training and evaluation of the binaural spectacles.

Clinical Trials of Reading Machines for the Blind
Central Rehabilitation Section for Visually Impaired and Blinded Veterans, VA Hospital, Hines, Ill. 60141
John D. Malamazian and Harvey L. Lauer

This project consists of testing and teaching the use of reading machines built and designed by Mauch Laboratories for the Research and Development Division of the Prosthetic and Sensory Aids Service.

Use and testing of the Cognodictor #2 with Visotoner probe were concluded. Recordings were made of the outputs of the instrument and of user performance. The Cognodictor "recognized" several type styles very well which enabled Visotoner users to read the spelled-speech output either alone or along with the tones. Among the many useful observations was the fact that individuals vary widely in initial facility with

the spelled-speech code, and this initial facility correlates highly with ability to learn the tonal code. The Cognodictor was returned to its manufacturer for redesign.

Telephone teaching of students was continued, and training of a new student was unsuccessful because he was unable to learn the code. Mr. Lauer went for a 2-week detail to the Western Blind Rehabilitation Center in California to work with Mr. Richard Bennett, who is beginning a project similar to this one, and to confer with researchers. He also presented a paper at the convention of the National Braille Association.

A study of the Bell Telephone data-coupling system was made with a view of coupling instruments to transmit data signals.

A report on the project over the past 3½ years was made. There were a number of visitors to the project, and Mr. Lauer wrote three articles for distribution and possible publication.

Development of Correspondence Courses for Personal Reading Aids for the Blind
The Hadley School for the Blind, Winnetka, Ill. 60093
Donald W. Hathaway and Margaret Butow

From January 1, through June 30, 1971, three students completed their studies of the Visotoner screening course. All three of these students are waiting to make arrangements for further training and for the opportunity to work with a Visotoner, should one become available.

From April 12, through April 23, one of the 1970 graduates of the screening course came to The Hadley School for direct training with a machine. She is a blind stenographer from Rochester, New York. She worked with the Battelle course and went through 50 lessons. The pages were read under the Colineator with the optical barrel set to read through the glass. The student had trouble pacing, and staying on the line properly, but could hear the difference between letter shapes quite well. After some practice, she was getting better at aligning the probe, and pacing properly. Since she has returned home, she has continued to read the Battelle lessons, but is again having trouble pacing and aligning the probe. The school has kept in touch with her by letter and phone, and a tape of her reading is expected shortly.

In March 1971 the Visotoner was demonstrated at a local Lions Club.

In May 1971 the second prototype of the Cognodictor was at The Hadley School for 2 weeks. This prototype was hooked up to a Visotoner probe so that one heard the tone patterns of the letters and the spelled-speech one letter at a time coming after each tone pattern. A tape recording was made, and sent to Mauch Laboratories, reading some material from the Battelle course with the Cognodictor. A tape of an

alphabet was also made. The purpose of these tapes was to show what a person with limited skill and time could and could not do with the Cognodictor. A recording of the Cognodictor output with Visotoner tone patterns was sent to Mary Jameson in England who showed it to the director of sensory aids research at St. Dunstan's and to two other people. This tape was returned to The Hadley School since when the third prototype of the Cognodictor is finished, the above-mentioned recordings would be obsolete. Hopefully this will be done later this year. With the second prototype, tracking and pacing were critical—one had to read right on the line. Recognition of some capital letters was difficult. There was some confusion with smaller letters, like d for k. The Cognodictor was returned to Mauch Laboratories at the end of May 1971.

During this time period, the Kansas Braille Reading Readiness text was obtained from the American Printing House for the Blind in order to explore the possibilities of using it for a tactile ability test which could be handled by home study. Again, the old problem of how to monitor the students came up. There was no good way to tell how the student would find and define the material on the page.

In the future, work will be done on the development of a course to determine people's ability to hear spelled-speech. The course would be tape recorded, and it is hoped that when the new spelled-speech output is finished, that this could be used for the tape recordings. For the first few lessons, just the human voice could be used.

Development of Test Procedures for Evaluation of Binaural Hearing Aids

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In March 1971 an invited paper dealing with work supported by contract with the Prosthetic and Sensory Aids Service was presented by Dr. Wayne O. Olsen at a Symposium on Electroacoustic Characteristics Relevant to Hearing Aids in Copenhagen, Denmark. The paper presented was entitled "The Influence of Harmonic and Intermodulation Distortion on Speech Intelligibility." It dealt with test results obtained for 36 sensorineural hearing-loss subjects when they heard speech in quiet and in the presence of competing speech that was amplified and reproduced by four hearing aids. On the basis of this work the following conclusions were reached:

1. The azimuth of the speech of interest and the competition relative to the good ear of a unilateral hearing-loss case, or the aided ear of a monaural ear-level hearing-aid user, is vitally important to them. Changes in location of the speech of interest and competition, as often happens in group conversations or conferences, can alter the listening

condition from one in which the speech of interest is readily understood to one in which it can be barely understood, if at all.

2. Listening conditions in noisy or competing speech situations, which are not difficult at all for normal hearers for their hearing and understanding of the speech of interest, prove to be very difficult for persons with sensorineural hearing loss.

3. Differences in speech discrimination scores with the various hearing aids were small in quiet or easy listening conditions but were considerably larger in more difficult competing speech conditions.

4. Various measurements and analyses of the physical performance characteristics of hearing aids result in markedly different rank ordering of the instruments relative to quality of performance.

5. With regard to physical performance characteristics and speech intelligibility, measurements of bandwidth and of difference frequency intermodulation distortion ranked the hearing aids in the same order as the average speech discrimination scores achieved by the 36 subjects. The best scores were achieved with the hearing aids having the widest bandwidth and least difference frequency intermodulation distortion, and poorer scores were obtained with the instruments showing successively narrower bandwidths and greater difference frequency intermodulation distortion. At least that was the case for the instruments used in this study.

At the present time, testing continues of subjects having bilaterally symmetrical hearing losses in monaural and binaural listening conditions under earphones and in the sound field of an IAC test chamber. This laboratory is interested in assessing whether or not persons having bilateral sensorineural hearing losses derive binaural release from masking when the phase of the test signal is out of phase with itself at the two ears while the noise is in phase interaurally and vice versa. It has been observed that binaural release from masking is observed for most persons having bilaterally symmetrical hearing losses, but that the release from masking is usually not as great as observed for normal hearers.

Responses to abrupt changes in sound pressure levels of hearing aids with and without compression have been the subject of investigation. At sound pressure levels near the saturation point and lower, the following response parameters have been estimated: 1. magnitude of overshoots for abrupt upward and downward changes of sound pressure level, 2. attack and release time, and 3. compression ratio. Results indicated that the release time was markedly influenced by the amount of overdriving of the amplifier as a result of the input sound pressure level. The gain setting of the hearing aid remained constant during these measurements. It was further established that the compression characteristic as advertised by some hearing-aid companies was absent.

Intelligibility studies, using connected discourse and the hearing aids mentioned above, are in progress. The main point of interest will be the influence of the magnitude of the release time upon speech intelligibility.

A study of the effects of shelf-life upon certain electroacoustic characteristics of 32 hearing aids has been completed. Over a period of one calendar year, each aid was periodically tested in order to evaluate the changes, if any, which might occur in an aid which was not in continuous use. Tentative results indicate some gain differences. Further analyses are in progress.