SENSORY AIDS

Edited by

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Fabrication of Obstacle Detectors for the Blind

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By January 1973, seven of the eight veterans with C–4 Laser Canes had been using them for 16 months. This measure of acceptance encouraged us to start making the community aware of the Cane. In the first 6 months of 1973, 11 visits were made to this end. Papers were given at three technical meetings (Biomedical Engineering Society, San Diego Biomedical Symposium, and the Council for Exceptional Children), and visits and conferences were held at eight institutions for the blind.

During this period, the C–4 Laser Canes in the hands of users were kept in repair. Further minor changes and experimental measurements were also made on the first models of the new C–5 Laser Cane.

Research on Audible Outputs of Reading Machines for the Blind

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Introduction

A frequent topic of complaint from the blind and visually handicapped concerns the long delays that occur in receiving recordings of spoken texts. The alleviation of these delays by means of a High Performance Reading Machine which can provide supplementary reading services to blind people is the goal of the research being carried out at Haskins Laboratories. From a technical standpoint, the results of this research indicate that the automatic production of spoken text from print is entirely feasible. Thus, a reading machine of this kind, installed in a major library, could respond to requests by individual blind subscribers by providing or recording clearly intelligible synthetic speech from ordinary printed texts. These recordings can be made at rates much faster than a human speaker can produce them. Hence, the availability of a fast library-based reading machine service could make a substantial contribution toward meeting the educational, recreational, and vocational needs of blind people.

Status of the Research

A prototype reading system has been constructed at Haskins Laboratories and has been in operation for nearly a year. Continuing efforts are being made to improve the performance of the machine at different levels; and high on the list of activities during the past 6 months have been the introduction of improvements in the quality of the speech and the incorporation of an optical character recognition (OCR) machine into the system to provide for the input of typewritten texts.

Looking ahead to the eventual deployment of a reading machine system, a collateral study which has gathered momentum during the past 6 months has focused attention on the intelligibility, comprehensibility, and acceptability of synthetic speech. The data from these tests are intended to show where efforts on speech improvement should be concentrated, and to test the reliability of the reading machine system. If, as expected, the results of these studies confirm the feasibility and utility of an automated reading system from both the technical and user standpoints, the resources might then be found to build a Pilot Reading Service Center. This Center would provide an experimental service to the blind community in its

area, and would act as a model on which other regional centers could later be based.

Installation of the OCR Equipment

The Cognitronics System/70 optical character recognition equipment, which the Laboratories purchased with funds from the Seeing Eye Foundation, has been installed and has been in operation since mid-March 1973. Since then, as a first step, an output program has been developed which punches a paper tape copy of the typewritten pages automatically scanned by the optical reader. This tape is then read by the DDP–224 computer which performs the remainder of the processing required to generate synthetic speech. As described in more detail in earlier reports, the DDP–224 computer—using a phonetic dictionary—converts the orthographically spelled text received via the tape reader into phonetic text. During the conversion of the text into phonetic form, stress and intonation markers are introduced in readiness for speech synthesis. If all the words contained in the original text have been found in the dictionary and if the punctuation available in the original text has provided an adequate guide to the insertion of intonation marks, synthesis proceeds automatically. However, editorial intervention is sometimes required and provision has therefore been made, just prior to synthesis, for an editor to check the dictionary output. New words are continually being added to the dictionary which now contains over 150,000 entries.

The use of the paper tape medium to convey texts from the optical reader to the main computer has been adopted merely as an interim measure. Work is in hand on the design and implementation of a direct electrical connection between the Cognitronics reader and the DDP–224 computer. This connection will permit rapid conversion of the fairly large volumes of text required for evaluation purposes—particularly for those requiring acceptability and tolerability judgments. One such evaluation project (for which the system is currently being readied) involves the regular conversion of articles from a New Haven daily newspaper into synthetic speech and subsequent appraisal by blind veterans at the Veterans Administration Hospital at West Haven, Connecticut. The New Haven Register provides the Laboratories with punched paper tapes of an article, whereupon the PDP–8 computer (which is an integral part of the OCR reader) is used to recode the text so that the DDP–224 computer can read it and perform the speech synthesis.

Synthetic Speech Evaluation

In the area of evaluation, the past 6 months have been occupied

on an analysis of the data obtained from a closed response version of the Fairbank's Rhyme Test and on the administration and analysis of a new test procedure using meaningless sentences. (The absence of meaning makes the recognition of words in continuous speech much more difficult.)

The Modified Rhyme Test, described in an earlier report, was administered in synthetic speech to 30 inexperienced sighted students and six blind students at the University of Connecticut. To provide a control test, the words were presented in natural speech generated by a single speaker. Three hundred monosyllabic words were used in six different orders of presentation. The overall intelligibility scores were found to be 92.5 percent for synthetic speech and 97.3 percent for natural speech—the former indicating needed synthesis improvements and the latter agreeing well with the data obtained by other workers. Initial /v/ and final /r/ in particular—as well as the labial, labiodental, and dental fricatives in general—were isolated as the least intelligible phones. However, an intrinsic limitation of the Modified Rhyme Test is that individual consonants are presented an unequal number of times, in unequal vowel environments, and in an imbalanced proportion of initial versus final syllable positions. The subjects' ability to recognize words in synthetic speech was shown to improve consistently over the course of the tests, thus it is possible that the low occurrence of some phones may have contributed to their low intelligibility scores. The finding that a listener's performance with synthetic speech improves with experience is consistent with the observations of many other workers. Customarily, the best scores are obtained if the "training period" with synthetic speech extends over several hours. However, this period is very short compared with the learning time demanded by *nonspeech* reading aids. In view of the fact that it is intended to be used on large volumes of reading matter, the modest amount of learning required in no way lessens the potential usefulness of synthetic speech in a Reading Service Center application.

The latest test to be conducted in the evaluation program utilized 126 nouns, 63 adjectives, and 63 past tense verbs—all monosyllables selected from the 2000 most frequently used words in English. Words from each category were randomly selected to create 200 meaningless sentences of the grammatical form exemplified in this sentence: "The gold rain led the wing." These sentences were recorded in both naturally spoken and synthesized speech in batches of 50 sentences with a 10 second interval between each sentence. During that interval, the 32 sighted subjects employed on the tests were required to write down the sentence they had heard in ordinary English orthography. Lacking semantic context cues, the

test proved to be the most difficult yet administered. A full phoneme-by-phoneme analysis of the natural speech and synthetic speech errors made by each subject has been undertaken to discover not only the most common confusions made but also the phonetic environments in which the errors occurred. A large volume of data has been obtained and the concluding phase of the analysis is still in progress. Discussion of the results will therefore appear in the next report.

Experiments in Alphabetic to Phonetic Conversion

While the reading machine output is being evaluated with a view to early deployment, research efforts are continuing toward the improvement of the speech output. By deliberate choice, the currently used methods of assigning and modifying stress in the phonetic string are simple and direct. The results, however, while being clearly superior to what might be expected if stress and intonation were totally absent, are not entirely natural. The problem of improving the intonation patterns in the speech output has two parts. One part involves the observation of natural speech patterns and the determination of rules relating these patterns to the syntactic and lexical content of the sentences. A second part involves the development of a flexible Experimental Synthesis Program in which the rules governing acceptable stress and intonation may be examined.

Comparison of the current synthesized output with samples of natural speech has recently led to new experiments involving the use of increased vowel duration as a supplemental cue for stress. In the Experimental Synthesis Program now being written, when a syllable is chosen to be stressed its lexical vowel is mapped into the phonetic output string as a diphthong or occasionally as a triphthong. This increase in formant excursion is applied in addition to the usual pitch excursion. When, on the other hand, syllables are marked for low stress, the vowels are in general mapped into the single vowel "shwa." Also all syllables moving from the phonetic dictionary to the output are additionally marked according to whether they occur in phrase-final position or not (a phrase in this sense being indicated by an intonation contour symbol). Thus, in the last phrase before a final end-of-intonation pause, trailing resonant phones as well as central vocalic phones are protracted. This gives a partially filled-pause effect which, together with the normal distinctive pitch excursion, highlights the conclusion of the phrase.

Using these methods, certain prosodic features observed in natural speech are emphasized in the synthetic output in sharp phonetic relief. This appears to increase the intelligibility of sentences,

although at the expense of naturalness. Further investigation will be required to obtain a satisfactory balance between the various cues which convey acceptable stress and phrasing within a synthesized sentence.

Speech Synthesis

A new OVE II cascade formant synthesizer has recently been installed as the output stage of the reading machine system. The OVE replaces a parallel resonance synthesizer that was built at the Laboratories several years ago. While in many respects less flexible as a general speech research tool, the new synthesizer has its formant filters connected in series. This arrangement is better suited to a reading machine application, since it establishes automatically the correct relative formant energy levels and reduces significantly the amount of calculation that is performed by the computer during the production of vowels. Synthesis programs designed for the OVE have been in operation since February 1973 and the device is already producing speech which seems better than that from the older model.

However, one of the most striking deficiencies of the OVE synthesizer is its limited performance on the production of nasals. The OVE has one parallel nasal resonator available, but spectrographic analyses of natural speech suggest that additional resonances and anti-resonances may be needed. At present, an investigation is in progress to discover the extent to which the perception of nasality can be enhanced within the limitations of the existing hardware. In parallel, a search is being made to find ways in which additional components, designed to generate the appropriate spectra, can be added. The results of this inquiry promise to provide a substantial improvement in voice quality and it is therefore being actively pursued.

Papers and Publications

The Haskins Laboratories research sponsored by the Veterans Administration was described in the following publications:

1. "Consonant Intelligibility in Synthetic Speech and in a Natural Speech Control (Modified Rhyme Test Results)" by P. W. Nye and J. H. Gaitenby, Haskins Laboratories Status Report on Speech Research SR–33, January-March 1973, pp. 77–91.

2. "A Plan for the Field Evaluation of an Automated Reading System for the Blind" by P. W. Nye, J. D. Hankins, T. Rand, I. G. Mattingly, and F. S. Cooper, IEEE Trans. Audio. and Electroacoustics AU–21, June 1973, pp. 265–268.

Aspects of the reading machine research were also reported in two

papers presented at the 85th meeting of the Acoustical Society of America held in Boston, April 10–13, 1973:

1. "Degree of Phrasal Stress: A Stable Lexical Feature?" by J. H. Gaitenby, G. N. Sholes, and G. M. Kuhn.
2. "A Two-Pass Procedure for Synthesis by Rule" by G. M. Kuhn.

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

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Hans A. Mauch and Glendon C. Smith

For progress during this report period, see "Abstract of Summary Report on the Development of a Reading Machine for the Blind (July 1973)" 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, Leicester W. Farmer, and James J. Whitehead

During this report period, the training, field testing, and clinical evaluation of the Binaural Sensory Aid (Models Mk I, and Mk Ia) continued. Four blinded veterans were trained with the Aid, bringing the total to 14 of the 16 projected to participate in the preliminary evaluation. Several of the veterans were visited in their home areas 6 months or more following training. Information concerning device utilization and function was recorded.

Following a meeting of the advisory panel on the "Preliminary Evaluation of the C–4 Laser Typhlocane" held November 1972, a decision was reached to enlarge the number of raters involved in evaluating performance videotapes of the eight subjects in the study. VAH Hines and VAH Palo Alto supplied the Orientation and Mobility Departments at VAH West Haven and Carroll Rehabilitation Center for the Visually Impaired (Newton, Mass.) with copies of the videotapes. Mr. William Ekstrom of VAH Palo Alto conducted the viewing sessions at each location. The resulting data will be included in the final report prepared by the panel for the Committee on Prosthetics Research and Development of the National Academy of Sciences-National Research Council.

On April 18, 1973, Mr. J. Malvern Benjamin, Jr., of Bionic Instruments, Inc., Visited VAH Hines to demonstrate the C–5 Laser Cane and collect viewpoints on an early prototype of the C–5 Laser Cane. Several points concerning modifications were discussed with the staff and two blinded veterans who participated in evaluation of the earlier model. Each blind veteran traveled briefly with the new model in downtown Chicago. The general comments were positive on the new prototype. Thirty-eight of the C–5 Laser Canes are scheduled to be delivered to the Veterans Administration in late 1973.

Mr. Farmer and Mr. Whitehead are participating on a panel (Task Group on the Objective Measurement of Mobility Performance, TGOMMP) to study new techniques of evaluating blind mobility. The panel sponsored by the CPRD of the NAS/NRC is under the chairmanship of Dr. David McGowan.

Apart from interests of the TGOMMP panel, efforts on developing better evaluation procedures have continued at Hines. Emphasis has been on device requirements, areas of potential utilization, and man-machine task compatability. Both objective and subjective tools are being refined. These include questionnaires, interviews, rating of videotape travel performance, and the numerical scoring of specific travel events. The improvement of techniques in videotaping is the primary challenge at this stage. Several newly blinded and experienced Long Cane travelers have been recorded in establishing various levels of travel efficiency to be used in future study.

Mr. Farmer participated in a conference on "Self Image and the Visually Impaired," held at the Chicago Lighthouse for the Blind on March 16, 1973.

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

The work of this project is the clinical evaluation of reading aids for the blind and instruction in their use.

The *Stereotoner:* The first production models of the Stereotoner were used and tested by Mr. Harvey Lauer. He demonstrated the instrument at Hines and in several other cities. Two former Visotoner students were instructed in the use of the Stereotoner. They were given several hours of supervised use after which they were ready for independent use. They are pleased with the instruments and are using them successfully.

The first stages of the evaluation of the Stereotoner took much work at Hines and a week at the American Institutes for Research, Palo Alto, California. An auditory selection test for the Stereotoner was devised in cooperation with personnel at AIR, and Mr. Lauer recorded the tapes for it. He also worked with other members of the evaluation team on a preliminary draft of the course of instruction and on testing procedures.

The *Optacon:* Mr. Lauer worked with two blind staff members on use of the Optacon. Both did well and are ready to help others in learning its use. He also made a 2-day trip to assist an Optacon student who needed help in addition to training received at another location.

For the purpose of deciding which reading aid would be best suited for their use, Mr. Lauer gave several hours of familiarization and instruction with each aid to each of seven people. The results were highly valuable both in suggesting prescription predictors and in comparing the human factors in using and teaching the Optacon and Stereotoner. The results of this preliminary work suggest that both aids should be taught at the same centers.

The *Varispeech Machine:* This is a variable-speed tape recorder equipped with electronics which eliminate pitch distortion as speed is increased. The result is speech compression capability up to 2.5 times recorded speed. Expansion is also possible. Ten blind college students and professional people were given an average of 7 hours each of experience with the varispeech machine output. This experience included prepared training tapes, personal instruction, and free access to the machine itself. All preferred the machine to non-compressed tapes for study purposes. When given a choice, all of them preferred at least double the recorded speed. Comprehension was checked at 1.75 times recorded speed or about 260 words per minute and found to be good.

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

The Visotoner Screening course continued to be taught from January 1 through June 30, 1973. There is currently an enrollment of seven students.

In April, a young lady from Israel came to The Hadley School for 3 weeks of training with the Stereotoner. She completed the screening course in January 1973. Although she heard the code well,

she had difficulty keeping the probe straight on the line even with the Colineator. She eventually had less difficulty with this and was able to use the straight edge tracking aid built for the Stereotoner. She would put single sheets of paper on the raised line drawing kit board from the American Foundation for the Blind. She had trouble relating the letter shapes to the tone patterns they produce. Since she finished her training, she has sent us tape recordings of her reading. Her tracking and code-hearing have improved. Her hope is to read Hebrew, and she sent us raised line Hebrew letters with a print copy. We made a recording describing the important points to look for in the Hebrew letter shapes. There are only 27 letters to deal with, and the shapes, in some ways, are less complicated than English letter shapes.

In May, a training-materials conference was held at American Institutes for Research in Palo Alto, California. The purpose of the conference was to enable the three Stereotoner teachers to discuss with the staff of AIR the development of materials for teaching people to use the Stereotoner. Fourteen units of three lessons each are being written, and the materials will be ready by Fall 1973. Another result of the conference was the development of an auditory selection test to be used in the screening of potential candidates for training. The test was given to over 35 people to validate it. Eleven tests were administered at The Hadley School. The Auditory Selection Test had a good distribution of scores and was validated.

The Stereotoner was demonstrated in Chicago at the convention of the Illinois Association of Workers for the Blind in April and at the conference of the Visually Impaired Computer Programmers in June.

Mobility and Reading Aids for the Blind, Centrally Directed Clinical Application Program
Western Blind Rehabilitation Center
VA Hospital
3801 Miranda Avenue, Palo Alto, California 94304
Loyal E. Apple, Richard Bennett, William Ekstrom, and Donald C. Cooper

Stereotoners 001 and 002 were used extensively by Mr. Richard Bennett, with prototype 001 being returned to Mauch Laboratories in March 1973 for updating. Mr. Bennett received a production model (#1005) in May 1973. Minor modifications in the latter, especially an improved and slightly longer cable, were found to be helpful. The new Stereotoner-Colineator Coupler permits use of the

Colineator for extended reading periods, while improvements in the straight-edge tracking aid made its use more desirable.

Coincident with the beginning of the Stereotoner evaluation by the American Institutes for Research, Mr. Bennett had frequent contact with Dr. Robert Weisgerber of AIR and his team. A five workday meeting at AIR and the Western Blind Rehabilitation Center took place May 7 through 11, 1973, attended by Dr. Weisgerber and his associates and by three VA reading machine specialists (Mr. Harvey Lauer of VAH, Hines, Illinois, Miss Margaret Butow of Hadley, and Mr. Bennett of WBRC). Products of this session included a preliminary draft of a Stereotoner instructional manual, a taped Stereotoner Auditory Selection Test, and other key ingredients of the evaluation project. Mr. Bennett administered the taped test to several WBRC staff and students. The purpose of this preliminary testing was to arrive at norms for use of the test in the Stereotoner trainee selection process.

Under the direction of Mr. L. E. Apple, Mr. Bennett prepared an information sheet describing the Stereotoner and a Criterion Sheet for Stereotoner Trainee Selection. These were distributed to appropriate VA personnel including Visual Impairment Services Teams, counseling and rehabilitation teams, and prosthetic chiefs.

One followup visit to a Binaural Sensory Aid (BSA) user was made by Mr. William R. Ekstrom, Blind Rehabilitation Specialist. Video tapes of the user's travel in his home area were taken. No followups were conducted on the other five users of the aid who were trained at the Western Blind Rehabilitation Center (WBRC). Either they were not utilizing them regularly, or were not in situations where they traveled independently, regularly. One additional veteran received training with the BSA in August and will be returning to college where he travels daily to classes. The evaluation of the C–4 Laser Cane was completed with the addition of one new aspect. The videotapes of the Laser Cane users were shown by Mr. Ekstrom to Orientation and Mobility instructors at the Carroll Rehabilitation Center in Newton, Mass. and also at the Eastern Blind Rehabilitation Center, VAH West Haven, Connecticut. These raters used the same rating form that the previous raters used at the Central Blind Rehabilitation Center, VAH Hines, Illinois, and at the WBRC. The additional data will be included in the final report on the Laser Cane prepared under the direction of the Committee on Prosthetics Research and Development. The new C–5 Model of the Laser Cane was examined briefly by Mr. Ekstrom and Mr. Donald C. Cooper when the manufacturer visited Palo Alto. The new model appears to be much improved and should be a more satisfactory travel tool when it becomes available in late 1973.

Mr. Thomas P. Coursey, Blind Rehabilitation Specialist, has been working with the Model 4909 Pocketscope (night viewing monocular which enhances ambient light) on an informal research project since March 1973. The scope itself has performed quite well with only a few malfunctions which the manufacturer has assisted in remedying.

Since acquiring the scope, Mr. Coursey has used it with 10 patients. He had each travel a simple residential route in an exceptionally dark area of the Stanford University campus. He also worked in the controlled situation of the low-vision room at the Western Blind Rehabilitation Center, checking acuity and checking to see if any of the patients could read large print. He found that seven of the patients were able to use the scope in the residential area and that the same seven were able to read the eye charts in the low-vision room. Only one patient was able to read large print.

Development of Test Procedures for Evaluation of Binaural Hearing Aids

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One study concerns the masking level differences (MLD) for pure tones and for speech exhibited by hearing-impaired persons both under earphone and in sound field. MLD's are obtained for 500, 1000, and 2000 Hz as well as for spondees and for monosyllabic words monaurally and antiphasically re homophasic reception. Eighteen sensorineurals have been tested to date. Twelve exhibited measurable MLD's, but the magnitudes of their MLD's were smaller than found for normals and less pronounced in sound field than under earphones. Twelve normals are being tested in the same way while miniature ceramic microphones are placed in the ear canals, thus providing information as to the head-baffle and head-shadow effects operating in the experiment.

Another project has been an evaluation of the hearing-aid recommendations of the Northwestern Hearing Clinic (Medical School) for the purpose of ascertaining how well the instruments recommended there coincide with instruments currently on contract with the Veterans Administration. The Northwestern clinic also uses non-contract aids. The purpose of the study is to supply information of the adequacy of the range in hearing aids procurable by VA via contract. Analysis of results is not complete but in 260 evaluations there were 16 conventional models that had each been tried at least 14 times. These models had recommendation-to-trial ratios ranging from 12 to 62 percent. Those hearing aids with the more favorable

ratios possessed internal adjustments available to the clinician. We are currently examining the respective recommendation-to-trial ratios in relation to differences in physical characteristics exhibited by these instruments.

A year ago we reported progress on a study to ascertain whether an excess drop in ability to discriminate monosyllables in white noise could be taken as a valid indicator that the person exhibiting such a drop would be a poor hearing-aid user. We have now dropped this exploration because other projects in our laboratories have shown that breakdown in discrimination in white noise is a very common phenomenon, and its predictive value for hearing-aid use appears very poor.

We have carried out a questionnaire survey, using 25 key items taken from the Dirks and Carhart questionnaire developed earlier under VA aegis, to evaluate hearing efficiency as experienced in everyday life either unaided or aided. This project is still in progress. Preliminary perusal of the returns reveals that most of the 128 persons reporting on unaided listening had either extreme difficulty or some difficulty not only in quiet situations but also in noisy ones where the level of the speech to be understood should have been intense enough to override the loss in sensitivity per se. When all data are gathered we will be particularly interested in determining, through comparison of responses for unaided and aided experience, in which situations a hearing aid may be considered beneficial and in which it makes understanding harder.

A further study that is underway is one comparing questionnaire reports of unaided efficiency with discrimination scores obtained monaurally in quiet and in 0 dB signal-to-noise ratio as well as in sound field at 50 dB hearing level. During aided listening, the earphone conditions are replaced by analogous sound field ones and these scores are compared with reports on aided efficiency. It is too early to draw any generalization on the relations which may emerge from these data.

We have tooled up for and are about to initiate an assessment of the types of speech discrimination errors made by persons with sensorineural hearing loss (as contrasted to errors made by normally hearing subjects) when the speech signal is distorted by filtering and/or peak clipping, etc. We are using the University of Oklahoma Test #6 for this purpose.

Influence of Input and Gain Values Upon Electroacoustic Properties of Hearing Aids

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G. Donald Causey, Ph. D., Earleen Elkins, Ph. D., Rosalind Green, Ph. D., and Eleanor Wintercorn, Ph. D.

Two frequency response settings on a hearing aid were investigated to determine if significant differences could be perceived by 11 subjects with sensorineural hearing impairments in both ears. The stimuli were pure-tones and narrow-band noise presented at the following frequencies: 250, 500, 750, 1000, 1500, 2000, 3000, 4000, and 6000 Hz. All testing was performed in a sound field under conditions which controlled the position of the subject relative to the sound source and the gain setting of the hearing aid. Stimulus presentation was randomized across subjects to minimize order effects, permitting some to receive the normal frequency response setting first and the low-suppression frequency response second, and some to receive the reverse order. The results were studied for stimuli differences and response setting differences. These results indicated significant differences at the .05 level of confidence among pure-tone and narrow-band stimuli at both response settings for the test frequencies of 250, 1000, and 6000 Hz. Although the other test frequencies showed significant differences for the two stimuli at the two response settings, the pattern of effect was different. Differences occurred at 250, 500, 750, and 6000 Hz with the pure-tone stimulus and at 250, 500, 1500, 2000, 3000, 4000, and 6000 Hz with the narrow-band noise stimulus. For both stimuli, the differences showed that threshold measurements were better with the normal setting for the test-frequencies below 1000 Hz and better for the low-suppression setting for the test-frequencies above 1000 Hz. Generally, these results indicate that the two frequency response settings of this particular hearing aid do show significant differences in how either pure-tone or narrow-band noise stimuli are perceived by persons with sensorineural hearing impairments.

Two studies surveyed VA hearing loss populations. One sample of 1097 hearing-aid wearers throughout the country had the severity of hearing impairment determined by the speech reception threshold (SRT). Those subjects with an SRT of 29 dB or less constituted 18 percent of the total population. Thirty-five percent of the sample had SRTs between 30 and 49 dB; 33 percent had SRTs between 50 and 69 dB; 9 percent had SRTs between 70 and 84 dB; and 5 percent had an SRT of 85 dB or greater. Thirteen classifications of hearing-loss configurations were identified for these five levels of

severity. Six configurations accounted for 87 percent of the cases. Thirty-one percent of the hearing-aid wearers had a gradual downward sloping loss of 5 to 10 dB per octave, and 19 percent had a marked downward sloping configuration of 10 to 30 dB per octave. Those subjects with a flat loss characterized by no greater than a 15 dB difference between the best and the poorest thresholds constituted 15 percent of the sample. Two configurations evidenced flat losses in the lower frequencies and severe drop-offs in the higher frequencies starting at either 1000 Hz or 2000 Hz. The former accounted for 12 percent and the latter accounted for 10 percent of those subjects surveyed.

The second survey considered a 4-month sample of all veterans examined at the audiology clinic in VA Hospital, Washington, D. C. As in the previous study, severity of the 458 hearing impairments was determined by the speech reception threshold. Surprisingly, 72 percent could be classified as having normal hearing for speech. However, about one-half of these subjects had significant deviations from what would be considered a normal pure-tone threshold. Seventeen percent of the total population were considered to have mild hearing impairments, 8 percent had moderate impairments; and 3 percent had severe impairments. Thirteen categories of audiometric configurations were identified; 44 percent of the sample had an essentially flat pure-tone configuration; 12 percent had a 5 dB per octave decrease, 12 percent had a 10 dB per octave decrease; 10 percent had a 5 dB per octave increase; and the remaining configurations were distributed among the other nine categories. The results of these surveys provide the Veterans Administration with valuable data to assist in the selection of hearing aids required for its clinical population.

The Reading of Printed Materials by the Blind
Behavioral Science and Technology Program
American Institutes for Research (AIR)
Palo Alto, California 94302
Robert A. Weisgerber, Ed.D.

The goals of this evaluation effort are to develop a basis for trainee selection vis-a-vis the Stereotoner, identify suitable candidates, develop special instructional materials, advise on training in both formal and informal settings, develop measures, and assess the progress of training in order that the potential of the device for veteran and non-veteran populations can be explored in a systematic way.

The field tryout is to include approximately 48 Stereotoner

trainees, of whom about 36 will be veterans and the remainder non-veterans. Actual training is planned to begin early in the fall of 1973 at four locations: The VA hospitals in Menlo Park, Hines, and West Haven, and The Hadley School for the Blind in Winnetka, Illinois.

Work Accomplished in the First 3 Months of the Project

During this period, project staff (Robert A. Weisgerber, Malcolm N. Danoff, Barbara J. Rodabaugh, and Susan E. Lalush) have concentrated their efforts in five areas. These are:

A. Preparation of descriptive announcements of the project and agreement forms for participants.

B. The collection of relevant information about trainee needs, prior teaching and research on related aural reading devices, and familiarization with the operation and fabrication of the Stereotoner.

C. The development and empirical tryout of a new Auditory Selection Test specifically for use with the Stereotoner.

D. The preparation of drafts for 14 units of instructional materials to be taught at each of the four training centers during a 2–3 week training period.

E. Preparation of a set of measures to be administered during the initial training period.

A. *Preparation of descriptive announcements of the project and agreement forms for participants.*

The announcement forms briefly describe the nature of the project and explain the potential benefits to be derived by blind individuals who might be eligible for training. The agreement forms specify the requirements and expectations of AIR (on behalf of the Committee on Prosthetics Research and Development) in connection with non-veteran candidates who would, as a consequence of training, receive a Stereotoner for their personal use.

B. *The collection of relevant information.*

Included in this aspect of the research has been a synthesis of the findings from: 1. prior research with the Visotoner and Battelle reading devices, and 2. the personal experiences and perspectives of three experienced Stereotoner users: Miss Margaret Butow and Messrs. Harvey Lauer and Richard Bennett.

Following a review of the available literature and the final reports of previous projects dealing with aural reading devices for the blind, a meeting was held at AIR in Palo Alto with five AIR staff members and three VA representatives in attendance. The meeting spanned five working days and resulted in a detailed plan for the content of the training course and agreement on the types of measures which

would be developed. Frequent communication by telephone conference call and by mail has assured that new viewpoints and information relative to the training materials and measures are coordinated with the instructors who will be using the materials.

Also during this period, a brief visit was made by the Principal Investigator to the Mauch Laboratories to meet key people and to see the engineering/manufacturing facility.

C. *Development and empirical tryout of a new Auditory Selection Test.*

An 84-item Stereotoner Auditory Selection Test was developed in tape cassette form with accompanying printed response sheets. It will yield scores concerning tone discrimination and tone shift, symbol counting, and symbol comparison. Complete instructions for field administration have been generated, as well. The test was developed with the help and consultation of Miss Butow and Messrs. Lauer and Bennett, and can now be used by them in an ongoing selection process for any and all future candidates for Stereotoner training. Approximately 30 subjects have been involved in a pilot test of the Auditory Selection Test. Data from this field test will provide a basis for establishing a suitable level of skill which should be demonstrated by candidates prior to their acceptance in the program.

D. *The preparation of 14 units of instructional materials.*

Instructional materials have been prepared in draft form for the following instructional units: Orientation (equipment familiarization, tone practice, tracking techniques), Numerals, Letters ATRE, Letters IHOS, Letters DLUN, Letters CGMF, Letters WPKQ, Letters YBV, Letters JXZ, Building Reading Speed, Additional Type Faces, Encountering New Formats, Equipment Operation and Utilization, Remediation and Special Help.

The instructional materials to be used by the trainee have been designed with a page format that will allow the blind trainee to enter the page and easily orient himself to each line of instruction without getting lost on the page. Much of the instructors' materials, which explain the use of the trainees' materials, has also been prepared in draft form.

All draft materials were reviewed in detail by AIR staff and VA representatives during the week of August 6–10, 1973, in Palo Alto.

E. *The preparation of a set of measures.*

As of the end of this reporting period, project staff had prepared initial versions of the *Tracking Test* and the *Trainee Profile* form. Work was underway on the development of items for the *Preference*

for Independent Reading measure and the interim and summary measures of *Stereotoner Criterion Performance.*

The *Tracking Test* will provide scores of the degree of tracking error, the duration of tracking error, and the rate at which an individual tracks across the page under two conditions: when the subject follows a reference guideline and also when no reference guideline is provided.

The *Preference for Independent Reading* measure will provide a motivational inventory of trainee interests and expectations.

The *Stereotoner Criterion Performance* measure will provide scores of reading rate, accuracy, and comprehension.

The *Progress Log* will provide summary data on study time on each unit, criterion exercise scores, and teacher comments.

Activities During the Next Quarter

During the months of August–October 1973, project staff are concentrating on the finalization of the training materials which are presently in draft form, and the reproduction of these materials in quantity. A similar objective is planned for the set of measures.

Four additional instructional units will be generated during the next quarter specifically for home study purposes. These will be concerned with: personal affairs, leisure activities, mobility and travel, and business communication.

Also during the next quarter formal instruction will begin and procedures for data flow will be put into effect.