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EDITORIAL: A Note from the Guest Editor

The history of research on braille reading is a history of sporadic effort. In the United States, the first half-century experience with punctographic reading codes was a history of conflict between competing codes - a conflict that was often sustained more by passion than by reason, and that was often unproductive. Early in this century, in an effort to resolve this conflict, the Uniform Type Committee (see American Association of Workers for the Blind "Fourth Biennial Report", reprinted in New Outlook for the Blind, 1913, 7, 1-48) conducted a number of experiments concerning the legibility of punctiform characters. The results of these experiements helped to bring about the agreement that was finally achieved concerning a standard braille code for common use in the United States. The differences between this code and the code adopted with much less difficulty in Great Britain were trivial, and as a result, braille reading matter in English could now be read by all members of the community of English speaking braille readers. Although the members of the Uniform Type Committee may not have intended it, their experiments also provided an incipient understanding of the perceptual basis for braille reading.

In 1932, the American Foundation for the Blind published Merry's translation of the book written by Burklen (Touch Reading of the Blind), that had been published in Germany in 1917. In his book, Burklen reviewed a number of experiments conducted by others concerning braille reading, and gave an account of a series of experiments he had conducted to determine the contribution of various factors to the perception of braille. His research was programmatic in character, and significantly advanced our understanding of the perception of braille.

The next programmatic effort was made by Eatman, nee Fertsch, who under the direction of Holland, conducted the research reported in her master's thesis (An Experimental Study of the Silent Reading Habits of Blind Childen, University of Texas, 1932) and doctoral dissertation (An Analytic Study of Braille Reading, University of Texas, 1942). The research method she developed allowed her to describe braille reading behaviour in enough detail so that it was possible to distinguish between the behaviour that characterizes fast braille readers and the behaviour that characterizes slow braille readers.

In 1974, the American Foundation for the Blind published a translation of Kusajima's account of his own research concerning braille reading (Visual Reading and Braille Reading: An

Experimental Investigation of the Psychology of Visual and Tactual Reading). In a number of experiments, conducted for the most part while he was a guest professor at the Pedagogische Hoschschule in the Ruhr, West Germany, he studied a variety of factors concerning the perception of braille. His research was programmatic, and his findings were in general agreement with the findings reported by Burklen and Eatman.

In 1969, the American Foundation for the Blind published the Perceptual Factors in Braille Word Recognition by Nolan and Kederis. In this monograph, they reported a carefully planned and extensive program of research concerning the legibility of braille characters and words. Because their research was systematic, the data they gathered enabled them to formulate a theory concerning the perceptual processes upon which the recognition of braille characters and words depends.

The research conducted by Nolan and Kederis made an important contribution to our understanding of the perception of braille. However, at least in one respect, it was not as influential as it deserved to be. Their experiments were carefully done, and their results were widely accepted. Their conclusions were accepted by many, and of course, disputed by others. Dispute is a sign of the health of a science. Scientific progress depends on it. However, the increase in research activity that might reasonably have been expected as a consequence of their work did not materialize. Since then, single experiments have been reported from time to time, and some of them have provided valuable information, but until recently, there has been none of the sustained and systematic research we must have if we are to achieve a level of understanding that will allow us to solve braille's serious problems.

A year or so ago, John Gill, the editor of the Braille Research Newsletter, told me that he was thinking about discontinuing its publication. He said that it was becoming more and more difficult to find news to report, and he was about to conclude that there was not, at present, enough research activity to justify its continuaton. I was sorry to hear this, because I had found the BRN to be my best source of information about research on the production and reading of braille. However, in view of the evidence he presented, I could not argue with his conclusion.

Months passed, and I began to hear from an increasing number of people for whom the BRN had also been a valuable source of information. At the same time, I began to see signs in the United States of a renaissance of research on braille. In 1980, the American Psychological Association included a symposium on braille research in the program of its annual convention. In 1981, the Southern Society for Philosophy and Psychology also included a symposium on braille research in the program of its annual convention. By participating in these symposia, I learned that there are now several sites at which programmatic research on the reading of braille is underway. Armed with this new perspective, I raised the issue of discontinuance of the BRN with John Gill again. He responded by challenging me to provide evidence in support of my impression, and he suggested that this might best be done by an agreement on my part to serve as guest editor of the next issue of the BRN. I saw that he had me backed into a corner. I accepted the challenge, and here is the result. This issue contains descriptions of several programs of research. The descriptions are brief, but I have provided the addresses of the authors who have submitted descriptions of their programs. If you want more information, please be assured that they will be flattered by your interest, and that they are eagerly awaiting your inquiries.

I do not claim that my coverage is comprehensive. I may very well have failed to include reports of important work in progress. The reports I have included are the reports I had in hand at the time at which it seemed to me there was enough material to make up a Newsletter. If, per chance, there is a reader whose work has been neglected, and who is smarting from the pain of unjustified exclusion, let me urge that reader to seek immediate redress of grievances by writing an account of the insufficiently appreciated work and submitting it to John Gill with all possible haste for publication in the next issue.

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Some Functions of Reading by Hand

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The variables regulating the perception and comprehension of braille are probably among the most unfrequently studied and least understood functions in the domain of haptics. Not only are we unsure of which perceptual and cognitive factors influence accurate braille reading, but there is also little in the way of theory upon which a solid empirical base can be built.

For the past few years, our laboratory has undertaken a study of haptic reading by blind adolescents. The focus has been on the effects of exploratory movement on the process of information pickup from braille, and retention of braille information. Our interest in exploratory movement stems from its well known effects on other kinds of haptic form perception and from its apparent significant role in the visual reading process. Our interest has been in designing a technology to permit unobtrusive study of hand movements during braille reading, and to link observed differences in scanning to reading ability, comprehension, and stimulus properties, including orthography, syntatic and linguistic features of the text.

We have recently completed a microanalysis of hand movements, permitting the following general conclusions:

(a) Proficient and nonproficient braille readers can be distinguished on the basis of several movement variables.
(b) Comprehension of braille seems influenced by search style.
(c) Hand movements in braille reading can be reduced to a finite number of microunits, based on direction and duration of the movement across the braille cell. These microunits appear relatively independent of the reading ability of the subject and the contents of the passage being read.
(d) Larger movement units (combinations of microunits) such as regressing movements and fixations, do seem to vary with ability of the reader and stimulus differences.

Our current experiments involve a computerised system for varying specific aspects of text, and processing the movement data. We are attempting to predict reading errors through studying the effects of these manipulations on the various components of hand movements identified in our initial studies.

The Relative Tangibility of Letters and Braille

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For nearly ten years I have been investigating which aspects of tactile pattern perception are comprehensible, or partly so, in terms of the limited spatial resolution of the sense of touch. During the last two years I have conducted several experiments indicating that the higher tangibility of braille characters relative to that of letters is explicable in terms of the limited spatial resolution of the finger (Loomis, 1981a, 1981b). The line of argument is expressed most simply using concepts of linear systems analysis.

Any image processing system is limited in capacity for transmitting fine spatial detail. Restated in spatial frequency terms, any real system filters out the higher spatial frequencies and thus transmits only the lower spatial frequency content of each input pattern. Because the finger is limited in spatial resolution and spatial extent, only the lowest portion of the spectrum of a pattern is processed by the sense of touch. My hypothesis for the higher tangibility of braille is that braille characters are more varied in terms of lower spatial frequency content than letters of the same size with the result that, since the cutaneous sense passes only the lower spatial frequencies, braille characters give rise to more differentiated patterns of neural activity in the somatosensory projection areas than do letters.

My strategy for testing this hypothesis has been to attempt to model touch in terms of low-pass filtered vision. If the tactile and visual form senses are similar except for the difference in spatial sensitivity, it should be possible to mimic the tactile form sense using visual recognition of characters that have been low-pass filtered. In the experiments I will describe, tactile recognition of embossed characters was compared with visual recognition of the same characters after optical low-pass filtering.

In the first experiment eight character sets, three of those braille and five letters, were used as the stimuli. The three braille sets varied in dot diameter while the five letter sets varied in both height-to-width ratio and stroke width. Of the letter sets, four were uppercase and one, lowercase. The uppercase letters and braille characters were all based on roughly the same character space of height equal to 5.8 mm. The eight character sets were arranged in concentric circles in the original artwork. A photoengraver produced an exact facsimile of the artwork in the form of a zinc disc with the embossed characters elevated .8 mm above the surface. The disc could be rotated about its center to position any desired character beneath the finger.

All stimuli were presented to the approximate centre of the distal pad of the right index finger. The subject lightly touched each character for about 1 sec in either of two ways: (1) with no lateral motion at all or (2) with very small circular motions of the finger, keeping the entire character always in even contact with the finger pad.

The visual stimuli were obtained by making use of the large negative employed by the photoengraver. The negative was affixed to a Plexiglass disc and mounted vertically. Single characters were back-illuminated, then blurred by diffusion and viewed monocularly by the subject. The degree of blur or low-pass filtering was adjusted so that visual resolution under these conditions was closely matched to tactile resolution as measured using a conventional resolution target. Stimulus duration in the recognition task was 1 sec.

Three sighted subjects were taught the 26 alphabetic characters of Standard English braille by sight without filtering and then participated in alternating sessions of visual and tactile recognition. Feedback was given after each trial.

The results for the two modes of touch were essentially identical and will be treated without differentiaion. The basic finding of the experiment was that the variations in tangibility and visual legibility across the eight character sets were highly correlated ($r = .98$). In particular, the three braille character sets were considerably more tangible and legible than the five sets of letters, lending strong support to the hypothesis set forth at the beginning.

If it is the case that under certain conditions blurred vision is an approximate model of tactile form perception, then one would expect tactile and visual character recognition to show parallel improvements with increasing character size, for as a character is increased in size, more of its spectrum is passed by a low-pass filter. The second experiment I will describe investigated the effect of varying character size on recognition performance.

One braille set and one uppercase letter set from the first experiment were reproduced photographically using five different magnifications prior to photoengraving. The five sets of letters and five sets of braille characters varied in height and cell height, respectively, from 2.8 to 8.6 mm. The procedure was very nearly the same as in the first experiment.

Not surprisingly, recognition performance (percent correct) increased with character size for both modalities and both character types. What makes the results interesting is that the increase in performance for both modalities occurred over the same range of character sizes. Since the two modalities had been matched in terms of spatial resolution, this means that performance for the smaller characters was being limited by the optical low-pass filter in the visual case and the intrinsic low-pass filter of cutaneous processing in the tactile case. The additional result that the braille characters were both more tangible than the letters throughout the range of stimulus size lends further support to the present hypothesis.

In a more recent study, I collected extensive tactile and visual recognition data on just two character sets, one of uppercase letters and the other of slightly smaller braille characters. These had been chosen on the basis of the previous work to give legibility and tangibility values (averaged over each set) of about 50% correct. When the tangibility and legibility scores for each of the 26 individual characters (of either letters or braille) were compared by product-moment correlation, the r values were +.86 and +.83 for letters and braille, respectively. This means that characters high in legibility tended to be high in tangibility and characters low in legibility tended to be low in tangibility. Furthermore, pairs of characters that were confusable for one modality tended also to be confusable for the other. This was demonstrated by correlating the corresponding confusion error scores (the off-diagonal values in the confusion matrices); the r values were +.72 for letters and +.53 for braille.

Although there were several systematic but small differences between the modalities not mentioned here, the three experiments together strongly confirm the hypothesis that low-pass filtered vision is an approximate model of tactile recognition and that braille characters owe their greater tangibility over letters to their greater distinctiveness in lower spatial frequency content, that which gets through the filter of cutaneous processing.

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A Word Superiority Effect with Braille Characters

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Braille readers may be able to palpate only one character at a time, but can they attend to several characters or an entire word or phrase at one time? To shed some light on this issue, I have had braille readers search for a particular braille character through a list of words and nonwords (letters in random order). On some trials, the target letter was present in one of the 25 words or nonwords on the page, but on other (catch) trials, it was absent. The conditions varied. Large characters printed by computer were used in some tests, and normal-size characters typed by a Perkins Brailler were used in other tests. In some tests, no constraint was put on the type of words used, whereas in other tests, I avoided using words and nonwords which contained contractions in Grade 2 braille.

Regardless of the test conditions, most subjects searched significantly faster through word lists than nonword lists, which indicates that braille readers are able to use their knowledge of English letter order or word contents to sharpen their ability to perceive a particular letter. Thus, in touch, as in vision, words reveal rather than conceal their component letters.

My subjects were able to combine the sensory information received on a particular letter with information gleaned from the word context on what the more likely letter candidates would be for that letter position, and as a result they were faster (and generally more accurate) in searching through word lists than nonword lists. In some tests, the time savings for searching through words (vs. nonwords) was about 10%, which is the same figure obtained in similar tests I have done in vision. This suggests that much the same sort of perceptual or cognitive processes are involved in word perception, irrespective of whether the word is registered by reading braille or by reading visually-presented material.

Braille Learning: First Experiments

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Approximately three years ago we began a program of research on the learning of braille. A review of braille research literature had indicated to us that there was very little information about the processes involved in the learning of braille. It was our belief that laboratory study of braille learning might be useful in helping identify some of the processes involved and, perhaps concomitantly, might be of some value in the design of braille training programs. We were aware also that little information existed about learning and memory in the haptic domain, and we thought that our study of braille might also add there to what is known.

Our initial work has focussed on learning the names for the first ten symbols of the braille alphabet. This is, of course, a paired-associate task, and the procedures we have used have generally been those from the paired-associate learning literature. In all of our experiments our subjects have been sighted college students at North Carolina State University. All were right-handed and were tested individually.

So far we have completed three experiments, in each of which visual and haptic presentation have been compared. In our first experiment (Newman and Hall, 1979), a 2 x 2 design was used in which on study trials subjects examined the items either visually or haptically and half of the subjects in each of these conditions were tested visually and the rest were tested haptically. Thus the groups were visual-visual, visual-haptic, haptic-visual and haptic-haptic. All subjects were given three study trials, each of which was followed by a test. One difference between the procedure for this study and that of the usual paired-associate learning study is that subjects were permitted to determine the length of time each item was presented both during study trials and during test trials.

Examination of the means for number correct, study time, and test time indicated that visual presentation of items on study trials was facilitative, as was visual presentation on test trials, with the study trial effect exceeding the test trial effect. However, since these results were confounded, we carried out a second experiment (Newman, Ramseur, Hall and Foster, 1980) in which again study and test modality were manipulated, as were study time (5 vs. 10 sec. per item) and test time (5 vs. 10 sec. per item). Thus the design was a 2 x 2 x 2 x 2. In other respects the procedure was similar to that of our first experiment, except that subjects were given five study and test trials rather than three.

The results for this experiment showed again that visual presentation on both study trials and on test trials was facilitative and, of course, performance was better when subjects had more time to study the items. The difference between the visual and haptic study conditions was greater at the shorter test times, whereas the difference between the visual and haptic test conditions was greater at the longer test times. Of particular interest in this experiment is that performance in the visual-haptic condition was better than in the haptic-haptic condition.

Our third experiment was done to provide information which, we believed, might help explain this outcome. The major variable of interest in this experiment (Newman, Hall, Goldston, DeCamp, Granberry-Hager, Lockhart, Sawyer, and White, 1980) was the size of the braille cell on study trials. For some of the subjects the items were presented in standard size braille on the study trials, whereas for the remaining subjects the items were presented in large (or jumbo) braille. In other respects several of the conditions replicated those of Experiment 2. Thus, during the study trials half of the subjects examined the items visually and half examined them haptically. Also, half of the subjects had five seconds to examine the items on study trials and the rest had ten seconds. On the test trials all items were presented in standard braille for ten seconds of haptic examination.

The main finding of interest in this experiment was a significant interaction between item size and study mode. The difference between the visual and haptic study conditions was significant when standard (but not large) braille was presented on the study trials.

In addition to the results reported above, we have obtained information in all three experiments about the order of difficulty of the individual items and about the types of errors made by the subjects. In each of the three experiments the orders of item difficulty were similar between treatments; the orders of item difficulty were also similar between experiments. In all three of our experiments, subjects were more likely to err by using the name for a symbol that had the same number of dots as the symbol presented than either more dots or fewer dots.

These results differ from those of Nolan and Kederis (1969, Experiment 1), but there are a number of differences between the procedures used in our experiments and in theirs which could have contributed to these between-experiment differences in outcome.

We have at present several studies at various stages of completion. Thus we are examining the effects of item order during study trials (alphabetical vs. nonalphabetical), of item set (A-J vs. K-T), of number of study modalities (one vs. two), of size of test item (standard vs. large), and of response name on the rate at which braille learning occurs.

As we mentioned earlier we have undertaken this research in the hope that we will be better able (than we are now) to identify the processes involved in braille learning and how they operate. We hope, also, that the results of our research program will contribute more generally to an understanding of learning and memory in the haptic domain.

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Patterns: The Primary Braille Reading Program

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The initial levels of Patterns: The Primary Braille Reading Program were marketed by the American Printing House for the Blind in September 1980. The sale of these materials marked the first time a reading program designed specifically for students who use braille as their reading medium was available to teachers and to students.

Patterns was developed in an attempt to overcome the significant problems young braille students had experienced in learning to read. These problems resulted primarily from the fact that the only materials available to teach these students to read were print materials transcribed directly into braille. Unfortunately, the order of presentation of vocabulary and skills in these materials were based on the print code, not the braille code. Since the two codes are vastly different, the vocabulary and skills in the transcribed braille materials were not ordered appropriately for the braille code. An additional problem encountered by young braille readers resulted from the fact that the numerous contractions in the braille code were encountered in many different forms at very early stages in the transcribed print reading programs.

The procedures used in the development of Patterns were designed to overcome, or eliminate, these problems. The initial step in the developmental process was a thorough review of the literature in (1) braille reading, (2) tactile perception, (3) concept development in blind children, and (4) print reading. Results of the review of literature on the braille code provided information related to the orders of difficulty of the various categories of the braille code, i.e. alphabet words, one-cell contractions, etc.; common errors made by braille readers, easily confused characters, etc. The review related to tactile perception provided information related to scanning techniques, appropriate tactile format, map reading, chart reading, and graph reading. The review related to concept development provided information to be used in selecting story content and activities to develop appropriate concepts. Certain aspects of the review of literature on print reading were used to select language activities and some teaching techniques appropriate for braille readers.

The next step in the procedure was to write a set of specifications to assist in the selection of vocabulary and teaching techniques for Patterns. These specifications have been published by the American Foundation for the Blind under the title Specifications for Selecting a Vocabulary and Teaching Method for Beginning Braille Readers (Caton, Pester, and Goldblatt, 1979).

Following the writing of the specifications, the writing of the Patterns program was begun. The program, in its entirety, consists of six levels: readiness, preprimer, primer, book 1, book 2, and book 3. The six levels do not imply grade level. They are simply used to provide an order, or sequence, to the program. Each level consists of the pupil's text(s), a teacher's manual, a criterion-referenced posttest, and review worksheets to be used in conjunction with the posttest. In addition, each of the levels from the preprimer through the book 3 level contains a set of worksheets to accompany the pupil's text.

The contents of the various levels were designed very carefully to take into account the unique characteristics of the braille code as well as the unique characteristics of the blind children who will use the program. The vocabulary is ordered on the basis of the difficulty of the braille code; the stories are related to the interests of blind children and many have characters who are blind or visually impaired; the concepts developed are those particularly needed by blind children; and teaching methods are related specifically to blind students, i.e. hand position and hand movement are taught.

The Patterns program was placed in educational programs, both day school and residential school, for a field trial in actual use by students. Each student began at the readiness level and progressed through the program at his own rate. Data gathered from the field trial were used to revise each level prior to its production.

In general, each level will be available for purchase as the field trial and revisions for that level are completed. As stated earlier, the initial levels are now complete and available for purchase. These levels are the readiness, preprimer, and primer. Book 1 will be available in September 1981; book 2 in September 1982; and book 3 in September 1983.

The results of the field trial have been very encouraging and students have made excellent progress in the program. Additional studies are being planned, with one now underway, to more precisely evaluate the effectiveness of the program. When more complete data are available, the results will be published.

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Braille Research in the Perceptual Alternatives Laboratory

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Mr John Kilpatrick, a research student in the Perceptual Alternatives Laboratory at the University of Louisville, is now gathering data for an experiment on braille reading that he will report in his doctoral dissertation. He hopes to obtain a description of the behaviour of braille readers that will be sufficiently detailed to extend the findings of Burklen (1932), Eatman (1942), Fertsch (1932), and Kusajima (1974) by obtaining a more precise and complete description of the patterns of behaviour that characterise fast and slow braille readers, and to draw inferences from these patterns of behaviour about underlying perceptual processes.

Kilpatrick employs two experimental tasks to elicit the reading behaviour he observes. In one task, subjects read braille text written on a transparent sheet of plastic that is mounted on a plate glass display surface. Beneath the plate glass, a front-surface mirror, mounted at an angle of 45^{o} to the plate glass, reflects an image of the underside of the sheet on which braille characters are written. This image is recorded on film by a motion-picture camera. The images recorded on the frames of this film are projected on a grid of rectangles, and the size of the projected image is adjusted so that a single braille character appears in each rectangle. By displaying the film in the conventional manner, Kilpatrick can observe the arm, hand, and finger motion of the braille reader. By displaying it a frame at a time, he can observe the characters written on the transparent sheet of plastic, and the character or characters that were being touched by the reader at the time each frame was exposed. Since the speed of the film is known, he can determine the time spent by a subject in contact with each character.

In the other experimental task, subjects read characters and words written on a tape that moves beneath stationary reading fingers at a speed that is initially too fast to permit their identification, and that is decreased from trial to trial until all of the characters and words have been identified. The tape is also used to present a discrimination problem in which subjects must decide whether pairs of dot patterns, presented at a speed that is gradually decreased from trial to trial, are the same or different.

Kilpatrick is now testing subjects. He expects to complete the collection of data this summer, and will analyse his results and finish writing his dissertation as soon as possible thereafter.

Mr Douglas Maure, Director of Technological Development Program, American Foundation for the Blind (AFB), has received a grant from the National Science Foundation to support his development of a paperless braille machine that can display a full page of braille at a time. In collaboration with Maure and with Corrine Kirchner, Director of Social Research at AFB, who is serving as the co-ordinator of Maure's project, I am conducting a few small experiments to gather information that will assist Maure in making some decisions about the design of the reading machine.

In one experiment, the objective is to determine the effect on reading speed of varying the separation between dots within and between cells. Three different displays are to be evaluated.

Standard spacing values are used to form the first display. When standard spacing values are employed, the separation between adjacent dots within a cell, horizontally or vertically, is 0.09 of an inch (2.3 mm). The separation between the centre of Dot 4 in any cell and the centre of Dot 1 in the following cell is 0.16 of an inch (4.1 mm). Thus, the separation between the centre of Dot 1 in any cell and the centre of Dot 1 in the following cell is 0.25 of an inch (6.4 mm).

The second display is formed by increasing the separation between the centres of dots within and between cells. The spacing values to be used are those provisionally incorporated in the AFB reading machine. The AFB machine will display slightly expanded characters, unless we obtain evidence that this should not be done, because the use of standard spacing values would make construction of its display mechanism more difficult. The centres of adjacent dots within a cell, both horizontally and vertically, are separated by 0.1 of an inch (2.5 mm). If a row of dots is written from one end of a line to the other on a slate or braillewriter, the row is interrupted after every two dots by the empty space that separates adjacent cells. The reading machine under development at AFB is designed to permit the formation of a row of equally spaced dots from one end of the line to the other, and the separation between adjacent characters is accomplished by inserting a column in which no dots appear. Thus the separation between Dot 4 in any cell and Dot 1 in the *following* cell is 0.2 of an inch (5.1 mm), and the separation between Dot 1 in any cell and Dot 1 in the following cell is 0.4

of an inch (10.2 mm). If these spacing values are used, text displayed on the AFB machine will require more space than the same text written in standard braille. Because it may be that text which requires more space is also read more slowly, we judged that it would be well to know how much reading speed might be sacrificed by increasing the separation between dots within and between cells.

The spacing values used to form the second display are also used to form the third display. However, whereas two columns are reserved in the second display for each character, even though only one column may be needed (consider, for instance, the braille letters "a," "b," "k," and "l"), in the third display, each character is alloted only the number of columns required for its formation. If two braille letter "a"s were printed in adjacent cells, they would be separated by 0.4 of an inch (10.2 mm) in the second display, and 0.3 of an inch (7.6 mm) in the third display. Thus, although the third display, like the second display, consumes more space than the first display, some space is saved by the elimination of unused columns. The AFB machine, as presently designed, can generate either the second display or the third display, but the benefit of the third display in terms of saved space depends on its cost in terms of readability. Although braille of the type used in the third display appears on preliminary inspection to be quite readable, the actual effect on readability of displaying it in this manner is not known. Accordingly, we have included the third display as a condition of our experiment.

The technique devised by Maure for displaying braille characters by raising patterns of pins above a display surface to the appropriate height permits the constructon of a display with as many characters per line and as many lines as may be desired. Although it appears that the implementation of his technique will be relatively inexpensive, the cost of a reading machine will still depend on the number of characters in a line that can be displayed at one time, and the number of lines that can be displayed at one time. It is likely that readability will depend, in part, on the values of these display variables that are chosen. We are therefore preparing for an experiment in which the number of characters that can be displayed in a line at one time, and the number of lines that can be displayed at one time will be varied systematically.

I have already indicated that the AFB machine can display full rows of evenly spaced dots that extend from the left-hand margin to the right-hand margin of its display surface. The AFB machine can also display full columns of evenly spaced dots that extend from the top to the bottom of its display surface. Thus, it will be possible to construct, on its display surface, any graph that can be formed by elevating the appropriate selection of dots in a dot matrix. We know that tangible graphs formed in this way cannot convey as much information as tangible graphs formed with continuous lines that can be varied in width, elevation, and curvature. Nevertheless, we believe that if their limitations are respected, graphs formed with dots will prove to be useful in some situations. Because limitations cannot be respected if they are not understood, we are planning experiments that will permit comparison of graphs formed with dots and graphs formed with continuous lines.

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SRF TAL & PUNKT

Projects Commencing 1 January 1981

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EDITOR's NOTE: Mr. Hampshire at SRF Tal & Punkt, the printing house of the Swedish Federation of the Visually Handicapped, has prepared this brief description of research underway at their recently organized development unit. Most of the projects described by Mr. Hampshire are concerned with the production and distribution of braille, but as you will notice, the development unit is also interested in exploring applications of synthetic speech.

1. Synthetic Speech

An evaluative study of the synthetic speech system developed at the Technical University of Stockholm.

This project has two main aspects. Firstly, to evaluate aspects relating to the centralised production of synthetic speech from compositors' tapes. It is intended that a weekly paper consisting entirely of "small ads" will be the material to be distributed during an experimental period. This paper has been chosen because of the high interest this material has for the visually handicapped, the material is not at all available to the visually handicapped at present and it demands the high rate of production which is potentially possible with computerised production.

Secondly, a series of experimental studies is to be carried out in co-operation with other institutions on the "readability" and acceptability of synthetic speech.

2. Compositors' Tapes

We are currently using compositors' tapes in our routine production. Further development of this part of our production will be carried out which will involve the investigation of organisational/copyright problems as well as technical problems.

In addition, use of a modem link with various compositors/ printers or other text services, e.g. text processors in organisations, institutions, etc. will be developed.

3. Braille Recorders

A survey of existing equipment with regard to its capabilities of being interfaced to our production system and of cassettes being duplicated on our "talking book" equipment. Initial practical trials will probably involve using TSI's Versabraille, as a suitable interface exists for this machine and its search facilities make it a more appropriate machine from the users' point of view. Our view at the present time at least, is that these machines are most appropriate for reference material, i.e. material of considerable bulk which only ever needs to be referred to rather than to be read from cover to cover.

4. De-Centralised Production

Investigation of establishing de-centralised writing facilities, the text from which can be transmitted to our printing house for printing in braille and/or "large" print. The aims of this development is to try and provide a better provision of local information to the visually handicapped.

The Braille Choral Music and "Ensemble" Score

C. Eldridge
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EDITOR's NOTE: In this article, Mr Eldridge does not describe a programme of research. However, he does review the history of a problem, reports his own experience in dealing with that problem, and indicates the need for evaluative research. The questions with which Mr Eldridge is concerned are important ones, for they remind us that the differences between the perceptual processes employed by those who read braille by touch and those who read print by vision have implications that extend beyond the identification of letters and words. These differences also have implications for the format in which information is presented, and this is the problem to which Mr Eldridge directs our attention.

Choir directing, for the qualified blind musician, can be one of the most viable and exciting avocations or vocations - but, unfortunately, it is one of the most neglected. Historically, the principal cause of this neglect was that until the International Conference on Braille Music (Paris, 1954), there was no practical, standardised, "tested" format for the reproduction, in braille, of the choral score.

Braille Choral Transcription Prior to 1954

What little choral music printed in braille, prior to the Paris Conference on Braille Music, was either in the "paragraph" method, in which the complete music and word texts for each voice of a section or entire composition were transcribed independently, or, in a format similar to that for the transcribing of piano music, wherein the soprano and bass lines are notated, and the alto and tenor voices are indicated by interval signs. Neither of these methods presented, in easily readable form, the complete span of polyphonic or homophonic textures and their accompanying word-texts.

The Full Choral Score Method (Paris, 1954)

The full choral or "ensemble" format is made up of parallels separated by a line space. Each parallel includes all voice parts, bar-over-bar, beginning, with voice-indicium, at the left-hand margin of the page, followed by the word-texts, in respective order, indented. If two or more lines of music or word-text are identical, they are printed on one line and so indicated. Whenever practical, performance directions are placed above the parallel. Everything possible is done to provide "quick" and easy reading. A more detailed description of this format, with examples, can be found in both the British and American manuals emanating from the accords of the afore-mentioned Paris Conference.

An American Addendum Modifying the Full Choral Score Music Format

In 1975, an addendum was appended to the American edition of the REVISED INTERNATIONAL MANUAL OF BRAILLE MUSIC NOTATION, which reverses the order and arrangement of the music and word-text in the parallel. Hence, in "sight-reading", the hand first accosts the word-text at the margin and secondly the music text, indented. The question is: Which area is most important to the conductor, the word-text or the music score? The choral director would answer, "the music score". The choir member can easily read the word-text. It is the music which must be taught and rehearsed. The original concept of the braille choral score was that the music parallel should be easily accessible and uncluttered. Placing the word-text first and at the margin, obscuring the vocal score, obviates the very purpose of the choral and "ensemble" method - which was intended to provide the blind musician a means of "quick" and easy reading of the entire choral score in rehearsal and/or performance, affording new opportunities and a greater professional equality with "sighted" muscians.

Thirty-Five Years Experience with the Original Choral Score Format

For thirty-five years (1939-1974), I successfully conducted choirs of sighted singers in a major cathedral, churches, high schools, colleges, opera workshops, etc. I read the score with my left hand, conducting and "cueing" with my right hand, head, body movement, "mouthed" directions, and all other means employed by sighted conductors, except eye contact. My library contains thousands of pages of hand-transcribed choral scores.

I feel that my years of experience in the use of the original choral and "ensemble" format should be an adequate field test.

Before any substitution for this method of score reproduction with any new arrangement, a very serious, unbiased, and comparable study should be undertaken. To my knowledge, such a full-scale study and test has not been made. If choral directing can become "one of the most viable and exciting avocations or vocations" for the blind musician, every means and method for realising this area of opportunity should be most carefully examined, and above all, adequately "field-tested".

Paperless Braille Devices

J.M. Gill
Warwick Research Unit for the Blind

Braille has not been superceded by other forms of non-visual media despite numerous predictions to the contrary. Although audio systems, such as the tape recorder, and aids with tactual or speech output play an important role in giving blind people access to information, braille is still supreme in its use for reference and technical material. Another important aspect is that a blind person can write braille without having to invest in expensive equipment.

However braille embossed on paper has a number of disadvantages - the principal one is bulk. Typically a braille book will occupy twenty times the volume of its equivalent in print. This provided the initial impetus for the development of systems for storing braille very compactly. Numerous systems have been tried including coding braille as dots on microfiche.

In such systems the braille is output on a transitory display such as an array of pins which can be raised to represent the braille characters. There have been severe technological problems in producing an inexpensive reliable display which is comfortable to read.

Recent developments have concentrated on adapting computer technology for the digital storage of braille on tape or disc. The first such system in routine use was developed in the Soviet Union as part of a communication system for the deaf-blind. The introduction of digital cassettes brought the prices down to a level where the devices could be considered for individual use. The decreasing cost of microprocessors has permitted the introduction of sophisticated searching and editing facilities.

All tape systems are slow for random access to information. Floppy discs have been used for a number of years in microcomputer systems to overcome this problem but, as yet, only one paperless braille system is marketed with disc storage. Access time is particularly critical for telephonists using a system for storing telephone numbers.

Most manufacturers offer interfaces for connecting to printers, so that the braille data can be produced in print. However all the present systems will only operate in this mode with uncontracted braille. Also word processing facilities (eg automatic centering of headings, underlining, page numbering) are not provided as standard on any of the commercially available devices.

Therefore one can expect significant improvements in the coming months as new facilities are added which will make significant difference to the application of these devices as aids to employment. Many of these new facilities will take the form of separate modules.

The choice of a system is not simple since it will depend on the specific application. This article attempts to point out the main features of the systems which are commercially available in the UK (NB the Braillocord is not available in the UK). The technical specifications in this article are based on information provided by the manufacturers and have not been checked by the author.

Table Commercially available devices

	Brailink	Braillex - C	Braillex - D	Digicassette	Versabraille
Storage media	mini	C-60	disc	C-90	C-60
No. of drives	2	1	2	1	1
Tapes require preformatting					*
Max. no. of cells (in 000's)	150	720	230	1000	400
Need to turn over tape		*		*	*
No. of cells on display	48	32	32-40	20	20
No. of buffers	2	1	1	3	1
Total buffer size (bytes)	4000	4096	4096	4800	1000
Braille keyboard	*	*	*	*	*
Alphanumeric keyboard	*	extra	extra		
Search by chapter		*	*		*
Search by page	*	*	*		*
Search by paragraph		*	*		*
Search by string	*	*	*	*	*
Search by record number	*	*	*	*	
Search by keyword		*	*	*	
Mean access time (secs)	47	120	2		16
Can record audio information		*		*	*
Variable audio speed control		*			*
Microphone included		*		*	*
RS 232-C interface	*	*	*	*	*
Max. baud rate	9600	9600	9600	2400	9600
Re-chargeable batteries				*	*
Time between charges (continuous use)				8	3
Operate from 240 volts, 50 Hz	*	*	*	*	*
Weight, kg	9	18	18	3	4
Basic price £ (incl VAT)		3450	3795	2967	3329
Price with interface (incl VAT)	5290	4945	5290	3956	3789
Installation and training	345	345	345	50	0
Delivery (weeks)	4	2	4		4
Warranty period (months)	12	6	6	12	12

Brailink

Manufacturer: Clarke & Smith International Ltd, Melbourne House, Melbourne Road, Wallington, Surrey SM6 8SD. Tel: 01-669 2464 & 01-669 4411. Telex 22574 answerback Casint G.

Description: The Brailink 3 is a self-contained portable intelligent computer terminal with braille display. It primarily facilitates the employment of blind persons in a computer environment. The terminal is designed to be used off-line or direct on-line to the computer. The blind user may thus create or revise data and directories in the home or office, whilst still using procedures similar to the main computer operating system. Many standard computer interfaces are incorporated in a single executive case.

The terminal consists of three user facilities:

1. The 48 character braille strip can display half a standard VDU line of data.

2. The keyboard and control switches. The keyboard can be switched between two modes. For terminal type operation the standard 56 key QWERTY mode will be preferred. For personal files and reports the 6 key Perkins mode enables contracted Grade 2 braille to be used for faster reading. Buffer control buttons are located by the display strip for easy reading. Buffer edit and line controls are duplicated on the keyboard.

3. Two digital data cassettes allow full editing of files to be executed, such as inserting unlimited blocks of new data anywhere in a multi-block tape. This editing process is based on the simple search and copy facility to find any specified word or sentence in the buffer or on the tape. Data is written in blocks of half a braille page; a cassette stores 150 blocks.

The text editor is line based with automatic buffer line numbering and status indication. The tape system uses two track Philips 3.81 mm cassettes with 6000 bits/sec transfer rate, 40K bytes per track, and 95 sec rewind time.

The system includes three RS232-C interface ports, and 'handshaking' protocols for a range of computers are available. The ports can operate at different baud rates.

Dimensions 460 x 360 x 140 mm. Weight 9 Kgs.

Prices: £4500.00 for Brailink, £300.00 for installation, commissioning and training, £100.00 for manuals for operating instructions. These prices exclude VAT.

Braillex C

Manufacturer: F.H.Papenmeier, Braillex Division, Talweg 2, Postfach 1620, D-5840 Schwerte, Federal Republic of Germany. Tel: (02304) 16005. Telex 8229622 pea-d.

Description: Braillex comprises an electronically controlled cassette deck, a built-in braille display, an electronic braille keyboard and a central microprocessor-based electronic assembly.

The register or card index function permits unsequenced information to be stored after entry of a code word (key concept). The entry of the code word is invariably performed in braille. The input of information relating to the code word can be done at the user's option in spoken language or braille. A selective display of the memorised data is obtained by simply entering the specific code word. For calling the memorised information, the user will enter the specific code word in braille through the braille keyboard. The code word will appear on the braille display for checking by the user. Operation of the "search" key is then sufficient to call all information stored under this specific code word and initiate the readout in braille or spoken language.

The dictionary function is intended for calling numerically or alphabetically sequenced key concepts and information of the dictionary type. There is a built-in logic circuit for retrieval of the key concept or information in a very short time without regard to the position of the magnetic tape.

The selective talking book function enables the user to supplement by personal coding of terms, pages, etc, any talking book that is available or yet to be compiled so that a selective recall of the book contents is possible. Coding operations can be performed during readout or at any subsequent time.

The braille book-reading function makes it possible for the user to read continuously braille-written books that have been transcribed onto magnetic tape. The set incorporates circuitry for the automatic feed, repetition or skipping of lines.

The programmed learning module enables the user to check by direct comparison the correct spelling of words entered by him through the braille keyboard. Manifold program structures can be realised by the multiple choice process.

The electric typewriter module serves not only for checking and correcting the typewritten text which appears simultaneously on the braille display but also enables the user to "file" a "copy" of the typewritten text in braille on the magnetic tape after entering a code word.

One or more keywords can be allocated to the same portion of text. The text can be recalled by one of several keywords. It is also possible to search for word fragments. Another feature is that there is no limitation on the relationship of keywords to text and vice versa; text can be as long as required, keywords can be entered nearly as required and, in practice, without limitation on the number of characters. Within the memory, every word being in the volume of the text (maximum 4096 characters) can be pointed out as an additional sub-keyword. Within the memory the access time is less than 1 second.

Braille reading is by continuous output from memory containing 4096 characters; reading and rereading by lines, skipping of lines, at a speed of 0.4 seconds per line. Braille writing is by continuous closed-circuit procedure (shifting of the line with a spacing of 4 characters). After entering a maximum of 4096 characters, the input is transferred to the tape; writing must be interrupted for a few seconds only.

All data, stored on tape can be changed and/or corrected with the choice of (a) the previous text is not cancelled or (b) the previous text is cancelled. To add some text, the previous text and additional text are recorded onto the next free space on the tape. Tapes can be duplicated by a high-speed copier.

Storage capacity is 720,000 characters on a C-60 cassettte. The search speed is 1600 characters per second.

Dimensions: 420 x 500 x 178 mm.

Prices: £3000.00 ex Germany excluding VAT.

Braillex D

Manufacturer: F.H.Papenmeier, Braillex Division, Talweg 2, Postfach 1620, D-5840 Schwerte, Federal Republic of Germany. Tel: (02304) 16005. Telex 8229622 pea-d.

Description: Braillex D features the same general arrangement of components as Braillex C while the cassette has been replaced by a diskette station with dual drive and the audio mode is omitted.

Each 5 inch diskette holds about 115,000 characters with an access time of 0.5 to 2 seconds. For example two diskettes could hold 3500 telephone numbers (64 characters per entry).

It is possible to copy diskettes within the same machine; this is important when producing copies of the operating diskette. Most operations are by the use of 3 buttons; it is not necessary for the user to know the features of the operating system.

Interfaces for typewriters and V24 RS232 available.

Price: £3300.00 ex Germany excluding VAT.

Braille-Notex

Manufacturer: F.H.Papenmeier, Braillex Division, Talweg 2, Postfach 1620, D-5840 Schwerte, Federal Republic of Germany. Tel: (02304) 16005. Telex 8229622 pea-d.

Description: Pocket-size electronic "notebook" to store braille with a capacity of 8000 braille characters. To read the stored text, Braille-Notex is connected to a Braillex, and the data transferred to the Braillex.

Dimensions: 150 x 105 x 35 mm.

Price: £300.00 ex Germany excluding VAT, plus £100.00 to change software in Braillex.

Digicassette

Manufacturer: Triformation Systems Inc, 3132 S.E. Jay Street, Stuart, Florida 33494, USA. Tel: (305) 283 4817.

Description: The Digicassette DC-20M incorporates a 20 cell braille display, a cassette tape unit and a braille keyboard.

Cassettes of any length can be used and no preformatting is necessary; a C-90 cassette can contain more than one million characters (about 1000 braille pages). Braille and sound can alternate on the same track without interfering with the other track, and will be automatically recognised. Program cassettes will allow the user to load specialised application software into the program memory.

Facilities include automatic tape indexing by record number, transfer of text from one tape location to another or from one tape to another. A 2000 character storage provides a full word processing capability with all attendent editing functions (delete, insert, find, save, cursor left, right, up, down, and other functions attributable to word processing on video terminals. All commands are performed from a braille keyboard.

A plug-in microprocessor controlled interface allows data transmission to and from computers. The device can also be interfaced to electronic calculators and typewriters.

The device weighs 3 Kg and the rechargeable batteries permit 8 hours continuous use between charges.

Dimensions 230 x 250 x 50 mm.

Price: £2967 for DC-20M, £3956 complete with interface, £50 for installation and training in the UK. These prices include VAT.

Versabraille

Manufacturer: Telesensory Systems Inc, 3408 Hillview Avenue, P.O. Box 10099, Palo Alto, California 94304, USA. Tel: (415) 493 2626. Telex 348352 TSI PLA.

Description: The Versabraille incorpates a braille keyboard, a 20 cell parallel (instantaneous) presentation braille display, and a high-speed digital cassette drive. The system's information organisation is the same as a book, with a table of contents, chapters, pages and paragraphs. Audio information can be recorded on the same tape, under braille chapter titles if desired.

Four hundred pages of braille can be stored on a C-60 cassette (200 pages per side); this corresponds to 400,000 characters. Up to 50 chapter titles can be assigned to each tape side; chapter length is at the discretion of the user. Automatic location of chapters and pages and audio recordings; paragraphs and text strings can be located within a specific page. Average time for random access of any page (one complete side of C-60 cassette) is 16 seconds.

Editing facilities permit the insertion, addition, deletion or substitution of text strings within a 1000 character page. Chapter titles can also be changed.

A built-in interface permits the connection by the user of a Versabraille to a computer, printer or another Versabraille (for intelligent duplicating of cassettes). Configuration control parameters (CCP's) are accessable from a menu by the user via the braille display. CCP's for "other" devices may be stored under chapter titles for automatic reloading.

Dimensions 240 x 360 x 105 mm. Weight 4.5 Kg.

Prices: £3329 for Versabraille, £3789 for Versabraille including RS232 interface. These prices include installation, training and VAT.

Footnote: This article is also being published in Inter-Regional Review and is reproduced here with the permission of the editor of Inter-Regional Review.

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