# DOCUMENT RESUME

ED 197 568 EC 131 775

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| TITLE | Some Factors Affecting the Learning of Braille. |
| PUB DATE | 80 |
| NOTE | 10p.: Paper presented at the Meeting of the American Psychological Association (Montreal, Canada, September, 1980). |
| EDRS PRICE | MF01/PC01 Plus Postage. |
| DESCRIPTORS | *Blindness; *Braille; Exceptional Child Research; *Performance Factors; Tactual Perception; Young Adults |


ABSTRACT

The study involving 96 undergraduates with no previous experience with braille investigated variables (such as size of the braille symbols) affecting the learning of braille. Data were analyzed in terms of the number of correct responses, item difficulty, and error patterns. Visual Ss did better than haptic Ss on the regular bralle items but not on large braille items. Findings supported the prediction that visual examination of the items facilitates the establishment of a stable, discriminable encoding for each item. Results also suggested that the relative difficulty of an item, and the tendency for items to be confused with one another are each relatively independent of the mode in which the items are presented on the study trials, and of the size of the items on study trials. Tables and graphs with statistical data are included. (SBH)

# Some Factors Affecting the Learning of Braille

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(Paper presented at meeting of the American Psychological Association, Montreal, September, 1980)

Although the braille system has been in existence for approximately one-hundred and fifty years, recent reviews of the literature (Foulke, 1979; Harley, Henderson and Truan, 1979) indicate that there is little evidence about how braille is learned. This is particularly so if one is interested in the initial stages of learning.

Recently we have been carrying out research in our laboratory on the learning of braille. The study we are reporting today is the third in our braille research program. In our first two experiments (Newman & Hall, 1979; Newman, Ramseur, Hall & Foster, 1980), we were interested in comparing intramodal and crossmodal effects. More particularly, we attempted to determine whether learning occurred more quickly if the same modality (as compared with a different modality) were used during study and test trials. In each experiment the subject's task was to learn the name of the braille symbol for each of the first ten letters of the alphabet (i.e. A-J). The main difference between our first and second experiments was that in the first experiment the subject determined the amount of time each item was present on both study trials and test trials, whereas in the second experiment, both study time and test time were controlled by the experimenter.

Similar results were obtained in both experiments. Learning was fastest when the items were presented visually during both study trials and test trials and learning was slowest when the items were presented haptically during both study trials and test trials. Of particular interest was the finding that subjects who studied the items visually but were tested haptically did better than subjects who studied the items haptically and were also tested haptically. Our explanation was that visual (as compared with haptic) examination of the items during study trials leads to the earlier establishment of a stable discriminable encoding for each item which is also appropriate when the items are presented for haptic examination on test trials. The present experiment was done to test one implication of this explanation.

In the present experiment we manipulated the size of the braille symbols which were presented on study trials. For half of the subjects the symbols appeared on the study trials in regular braille (the size of the regular braille cell is approximately 4 x 6 mm.) and for the remaining subjects the symbols appeared on the study trials in large (or jumbo) braille (the size of the large braille cell is approximately 6 x 9 mm.). In addition, half the subjects in each treatment were exposed to the items visually during the study trials and half were exposed to the items haptically. Finally, study time was also varied so that half of the subjects in each treatment were allowed five seconds and the rest, ten seconds to examine each of the braille items. On test trials all of the items were presented in regular braille and each subject was allowed ten seconds to examine each item haptically. Again, as with our first two experiments, the subject's task was to learn the name of the braille symbol for each of the first ten letters of the alphabet.

Our particular interest in this experiment was in the relationship between study modality and item size. We predicted that their interaction would be significant, visual examination leading to faster learning when the items were presented in regular braille but not when they were presented in large braille. This prediction was based on the assumption that increasing the size of the braille cell would enhance item discriminability when the items were presented haptically on the study trials; however, since the items were readily discriminable when presented for visual examination in regular braille, increasing the size of the braille cell would have little effect.

## Method

Materials. The subject's task was to learn the name for the braille symbol for each of the first 10 letters of the alphabet (See Figure 1). The symbols, either in regular braille or in large braille, were presented to the subject on a thermoform strip.[1] The same items were used in both the visual and haptic conditions.

Procedure. The procedure was like that used in paired-associate learning experiments in which the rate on both study and test trials is controlled by the experimenter. Subjects were told, prior to the start of training, about the modality in which the items would be presented on study trials and on test trials, about the rate at which the items would be presented on study trials and about whether the size of the items would change or would remain the same between study and test trials.

All subjects were then given five study trials, each followed by a test trial. During study trials the experimenter called out the name of each item as it was presented. On test trials the subject examined each item and then called out its name. Subjects were given either 5 or 10 seconds to examine each item during the study trials. During the test trials, all subjects were given 10 seconds to examine each item haptically. When the items were presented visually on study trials, the subject looked at the symbol, but did not touch it. During haptic presentation, on both study and test trials, the subject's right hand was covered so that visual examination of the symbols was precluded. The subject explored each symbol by rubbing the flat portion of the right index finger over the symbol. The items were presented in a different order on each study and test trial. Two sets of orders were used, each for half the subjects in each treatment.

Subjects and Design. A 2 x 2 x 2 design was employed in which Size of Braille (regular or large), Study Time (5 or 10 seconds), and Study Modality (Visual or Haptic) were manipulated. The subjects were 96 right-handed male undergraduates at North Carolina State University, none of whom had had previous experience with braille. They were assigned to treatments in a counterbalanced order and were run individually.

## Results

Number correct. The means for correct responses for each treatment are presented in Table 1. An analysis of variance gave significant effects for

Study Modality, ($F(1,88) = 21.55$, $p$, $< .001$, Study Time, $F(1,88) = 11,37$, $p < .001$ and for the interaction of Study Modality and Study Size, $F(1,88) = 8.10$, $p < .01$. Examination of the means showed that the Visual mean exceeded the Haptic mean when the items were presented in regular braille, but not in large braille. This interaction is shown in Figure 2. The means for correct responses on each trial for the four study modality-item size treatment combinations are presented in Figure 3.

Item Difficulty. For each study modality-item size combination (collapsed across study time) the total number of correct responses was determined for each of the 10 symbols. Rank-order correlations were then done for these data for each pair of treatments. The results appear in Table 2. All of the correlations are positive and significant ($p < .01$). The order of difficulty of the items (summed across treatments) from most to least difficult was D, H, J, F, I, E, G, C, B, A.

Error analysis. The number of times each item elicited the name for every other item was determined for each study modality-item size combination and rank-order correlations were done for each pair of treatments. Table 2 presents these correlations. Again all of the correlations are positive and all are significant ($p < .01$). The most frequently occurring errors (summed across all treatments) from most to least frequent were JG, FD and JH, DF, EI, DH and HD, HJ, CB, DG, and HF, where the first letter stands for the item presented and the second letter the subject's response.

The error patterns were examined also by determining whether the subjects responded with the name for a symbol that had more than, less than, or the same number of dots as the symbol presented. In the 90 cells of the error matrix for the items used in this study, there are 33 possibilities in which an error would involve naming a symbol with more dots, another 33 cells for errors involving the name of symbol with fewer dots and 24 cells where the error involved naming a symbol with the same number of dots as the symbol provided. The data show that the mean errors per cell were 9.85, 9.30 and 26.00 respectively. The proportion of these types of errors in the error matrix were .238, .258 and .504 respectively. Thus, 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 by using the name of a symbol with more or with fewer dots.

## Discussion

Visual subjects did better than haptic subjects on the regular braille items (as in our two previous experiments) but not on large braille items. This result was evident on the first trial and continued throughout training. These findings accord with the main prediction for this experiment and support our suggestion that visual (as compared with haptic) examination of the items facilitates the establishment of a stable, discriminable encoding for each item. These results appear to provide support for the position recently proposed by Tulving (1979), that recall of an item is a direct function not only of the degree to which the context during the study (encoding) trial matches the context during the test (retrieval) trial, but also of the degree to which the encodings of the items are discriminable from one another.

The high positive correlations between treatments for item difficulty and for error patterns are also similar to the results from our first two experiments. These results suggest that the relative difficulty of an item, and the tendency for items to be confused with one another are each relatively independent of the mode in which the items are presented on the study trials, and of the size of the items on study trials.

Nolan and Kederis (1969, Experiment 1) have reported that "missed dot" errors accounted for 86% of the incorrect responses in their study in which blind skilled braille readers were to identify each of 55 different braille symbols. They reported also that the number of missed dot errors (1) was inversely related to the number of dots in a symbol and (2) was greatest for symbols with dots on the bottom row.

In our study, "missed dot" errors accounted for only about 25% of the total number of overt errors. This difference in outcome between our study and theirs may derive from between-experiment differences in subjects' experience with braille and at least to some extent, from differences in the set of stimuli used in the two experiments. More specifically, our symbols had fewer dots than theirs (means of 2.50 and 3.31 dots per symbol respectively), and our symbols used only the two top rows of the braille cell whereas their symbols used all three rows. With more dots per symbol and with all three rows being used, the error patterns of our subjects may have been more similar to theirs. Results from a study currently being done in our laboratory may provide additional information about the effects of these two factors. This study may help, also, to determine the extent to which the letter names of the symbols, and the way in which these names are matched to the symbols, each affect both the rate at which braille is learned, and the types of errors that occur during the learning of braille.

Footnotes

We thank John Calloway, Governor Morehead School for the Blind, for thermoform supplies and for the use of thermoform equipment, and Donald Mershon for comments on an earlier version of this manuscript.

[1]A description of the display apparatus may be obtained by writing Anthony Hall, Department of Psychology, North Carolina State University, Raleigh, North Carolina 27650.

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Table 1

Mean Correct Responses During Training for Each Treatment

| Study Modality | Item Size | Study Time (Sec.) | Mean Correct |
|---|---|---|---|
| Visual | Large | 5 | 33.67 |
| Visual | Large | 10 | 37.83 |
| Visual | Regular | 5 | 34.92 |
| Visual | Regular | 10 | 39.50 |
| Haptic | Large | 5 | 30.67 |
| Haptic | Large | 10 | 35.42 |
| Haptic | Regular | 5 | 22.50 |
| Haptic | Regular | 10 | 29.33 |

Table 2

Rank - Order correlations for Item Difficulty and for Types of Errors Between Pairs of Treatment Combinations[a]

| Treatment Combinations | Item Difficulty | Types of Errors |
|---|---|---|
| Visual-Large and Visual-Regular | .988** | .793** |
| Visual-Large and Haptic-Large | .952** | .761** |
| Visual-Large and Haptic-Regular | .945** | .753** |
| Visual-Regular and Haptic Large | .936** | .735** |
| Visual-Regular and Haptic-Regular | .924** | .787** |
| Haptic-Large and Haptic-Regular | .948** | .818** |

[a]Collapsed across study-time.

** $p < .01$

Figure 1

Braille Symbols for Letters of the Alphabet

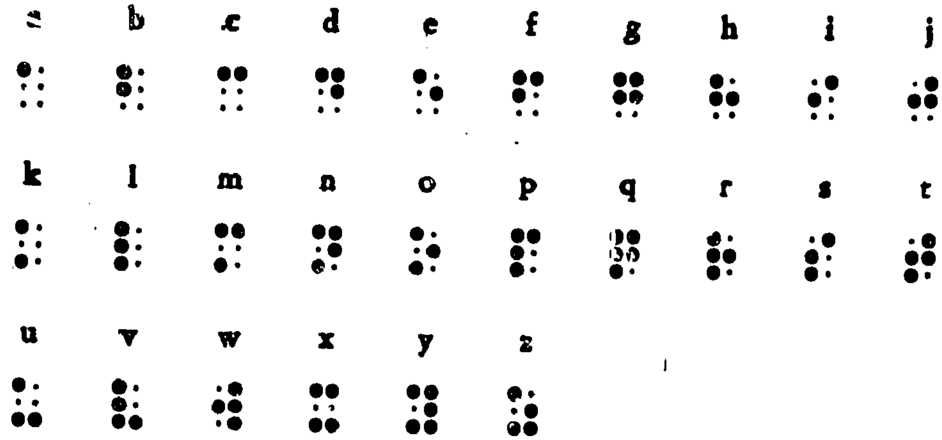

FIGURE 2

STUDY-MODE x ITEM-SIZE INTERACTION:
TOTAL CORRECT RESPONSES

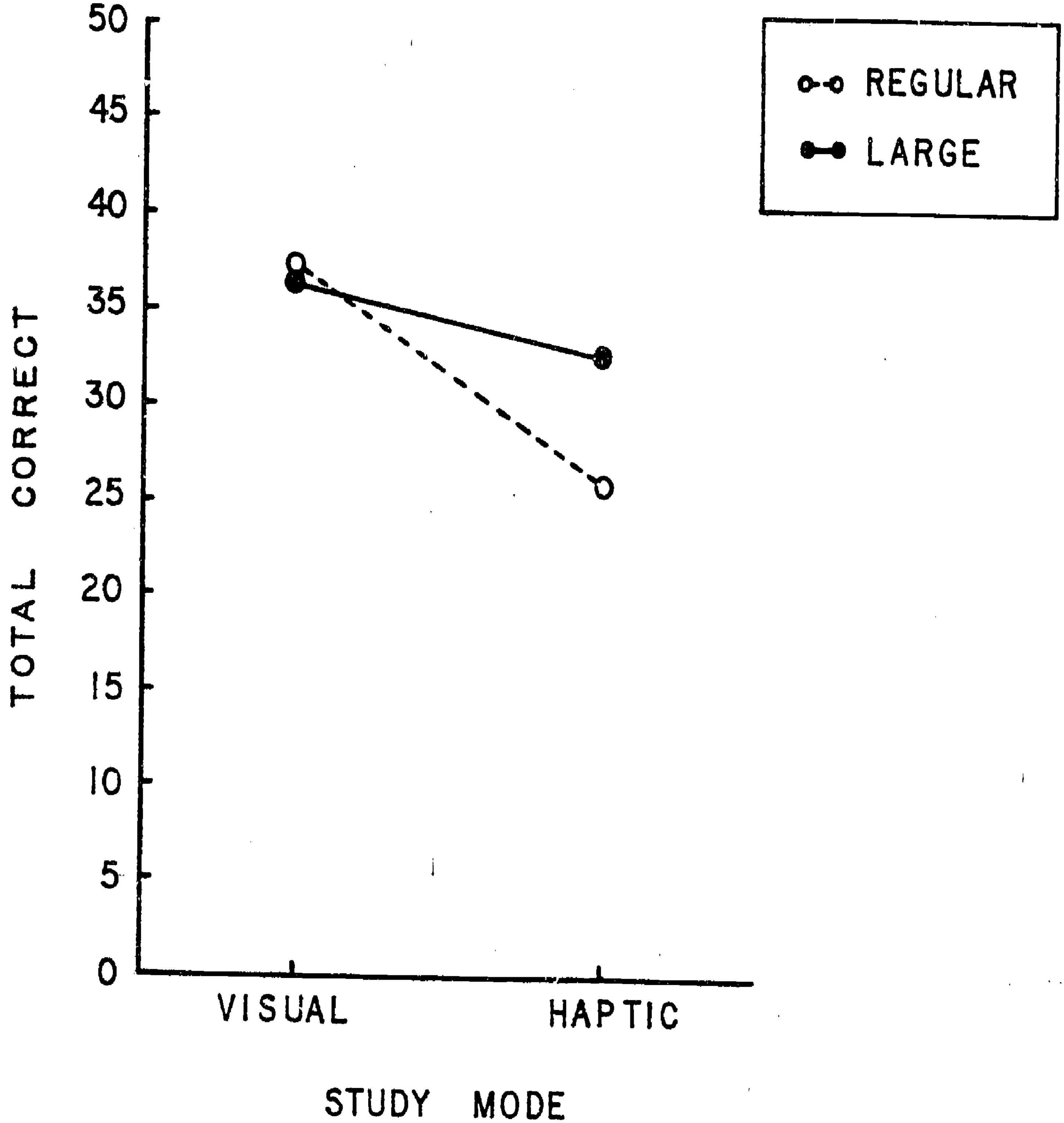

FIGURE 3

# MEAN CORRECT RESPONSES DURING TRAINING (COLLAPSED ACROSS STUDY TIME)