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ABSTRACT

The effects of rule knowledge were investigated using Braille inkprint pairs. Both recognition and recall were studied in three groups of subjects: rule knowledge, rule discovery, and no rule. Two hypotheses were tested: (1) that the group exposed to the rule would store better than would a discovery group and a control group; and (2) that all three groups would have higher scores on the recognition task than on the recall task. Subjects included 119 undergraduate students randomly divided into three groups. Members of the rule knowledge group were told the underlying pattern in the braille alphabet, and their worksheets reflected this pattern. Members of the discovery group were not told the underlying pattern, although their worksheets allowed discovery of the rule. Members of the control group were not told about the pattern, and their worksheets were arranged to make discovery extremely unlikely. Subjects were asked to store and retrieve 26 specific dot pattern-inkprint letter pairs. The results indicate that the rule knowledge group outperformed the other two groups, but there was no difference between the recall and recognition performance. Results are discussed in relation to current models of rule learning and differences between recognition and recall procedures. Two data tables, one bar graph, and four sample worksheets are provided. (RLC)

The Effect of Rules and Discovery in the Retention and Retrieval of Braille Inkprint Letter Pairs

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Running head: BRAILLE PAIRS

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Abstract

The effects of rule knowledge were investigated using Braille inkprint pairs. Both recognition and recall were studied in three groups of subjects: Rule Knowledge, Rule Discovery and No Rule. The results indicated that the Rule Group outperformed the other two groups, but there was no difference between the recall and recognition performance. Results are discussed in relation to current models of rule learning and differences between recognition and recall procedures.

Introduction

In order for information to be available for subsequent retrieval it must be stored in long term memory (LTM). Encoding is the process of transforming information, both verbal and visual, in order to facilitate storage. There are several encoding mechanisms that have been identified as effective. Maintenance rehearsal (Woodward, Bjork, & Jongewood, 1973) is one method of encoding in which information is simply repeated. In contrast, elaborative rehearsal encodes information after transforming it in some way making it different and processing it at a deeper level (Reder, 1980). Elaborative rehearsal has been found to be more effective for later retrieval by several researchers, (Posner, 1973; Tulving 1983).

Tulving (1983) has described three forms of memory: episodic, semantic, and procedural. Episodic memory relates to our personal experiences, and by its nature is likely to receive elaborative rehearsal during the encoding process. An example of episodic memory is when someone remembers what they were doing on New Year's day or at a specific event. Semantic information, on the other hand, is less likely to receive spontaneous elaborative rehearsal because it relates to general facts or information (Tulving,1983). An example of semantic memory is the recall of word meaning such as the meanings associated with the word "brick". Therefore, storage and retrieval of semantic information is usually less efficient, and might benefit from conscious elaborative strategies. Procedural memory is used for skills one exercises automatically, such as speaking grammatically or riding a bicycle.

The type of encoding will effect the manner in which information is stored and organized in LTM. Organized structures of knowledge were first described by Bartlett (1932) as "active organizations of past action". These structures, called schemas, serve as more than passive storage areas. Schemas provide a framework or network to establish linkages between new and old information. Absence of these networks or neural connections make storage and retrieval of new information more difficult.

The use of explicit rules as a vehicle for investigating information retention is common in many studies. Nosofsky, Clark & Shin (1989) studied the effect of rules on the categorization and retention of specific patterns. Their results indicated that, for pattern recognition, knowledge of rules produced superior performance. Two studies (D'Amato & Diamond, 1979; D'Amato & Guber, 1982) investigated the effect of rules on recall and recognition of paired-associates. Their results on word pairs showed better performance by the rule-supplied group on the paired-associates tasks. Interestingly, the improvement was found on the recall task, but not on the recognition task. The authors suggest that the results support a response-restriction hypothesis. This hypothesis contends that recall is improved by reducing the number of potential responses and thereby increasing the probability of successfully recalling information. Success at recognition was higher than recall, but the rule-supplied group performed no better than the "rule-ignorant" group. The authors attributed these findings to the fact that knowledge of the rule, in this instance, does not reduce the number of potential answers in the recognition task.

One distinction between recall (reproduction) and recognition was made clear by the "penny" study of Nickerson and Adams (1979). Adults had great difficulty when asked to recall and locate (reproduce) eight main features of an U.S. penny. When asked to identify the correct drawing of the penny from a group of fifteen options (recognition), the subjects performed better, although still exhibiting a significant number of errors. The results highlight a major difference between recognition and recall, but also point to the level of encoding for semantic information discussed earlier. The subjects' difficulty on both tasks can be attributed to a "need-specific" level of encoding, which does not appear to be very deep in order to use a penny. Need specific encoding refers to the processing of the stimulus to a level appropriate for expected task demands. In the case of recognizing a penny, there are many contextual cues that contribute to recognition.

Rarely are people asked to recall the actual characteristics of a penny except in experimental settings. It seems given a certain level of encoding, it is easier to recognize a familiar object than to recall its specific components. This apparent difference between recall/reproduction and recognition may be specific to the object to be encoded and then recalled, and also might be dependent on previous exposure and the existence of related schema.

In the present study, subjects were asked to store and retrieve 26 specific dot pattern-inkprint letter pairs. In order to investigate the differences in the results of the studies by D'Amato and associates (1987, 1982) and Nosofsky et al. (1989), subjects in the present study were tested for both recall and recognition.

The purpose of this study was to investigate the research hypothesis that the group that received the rule would score better than a discovery group and a control group. The design allowed an extension of previous studies of the effect of rules on retrieval and provided the basis for investigation of a second hypothesis. The second research hypothesis was that, consistent with most previous research, all three groups would have higher scores on the recognition task than the recall task.

Methods

Subjects

Subjects for the study were 119 undergraduate students randomly divided into three groups. Group one was told the underlying pattern in the braille alphabet and their worksheets reflected this (Rule Group). Group two was not told the underlying pattern, although their worksheets allowed discovery of the rule (Discovery Group). The members of group three were not told about the pattern, and their worksheets were arranged to make discovery extremely unlikely (Control Group).

Apparatus

Slides of braille letters with the inkprint equivalent were made into a video. This video included an introduction narrative, a short history of braille, the design and numbering system for the braille cell, worksheet directions, and achievement goals for the subjects. The video presented each braille/inkprint pair for 15 seconds. Slides were presented in alphabetical order, with a one second blank screen between letters. The video was modified for the Rule group. Before being shown the letter K, the students were told that the second group of ten letters was formed by using the pattern from first ten letters with the addition of dot number three. Before the letter U was shown, the students were told that the third group of letters was formed by using the first six letters with the addition of dots number three and six.

In the braille alphabet, the letter W, which was little used in the time of Louis Braille, does not fit the pattern. For the purpose of this study, the letter W, and subsequent letters were modified to fit the pattern. Thus the braille letter X became W, Y became X, Z became Y and the "and" sign (&) became Z.

Worksheets consisted of inkprint letters in alphabetical order, with a blank braille cell containing six small dots as reference points (See Appendix A). Worksheets for group one and two consisted of three rows of ten cells each, with the inkprint alphabet printed above the cells. Worksheets for group three consisted of four rows of seven cells each.

Procedure

Students received worksheets and were instructed, in the video, to duplicate the braille letter on the blank braille cell under the corresponding inkprint letter. After all braille letters were duplicated on the worksheets, the students were told that they have five minutes to study their worksheets. At the end of the five minute period, the worksheets were collected.

Students were tested separately for recall of braille letters (reproducing a braille letter when given the inkprint equivalent) and recognition (supplying an inkprint letter when presented with a braille letter). The order of test administration was counterbalanced. At the end of testing, students were asked to report learning strategies used, any prior knowledge of braille, and acquaintance with braille readers.

Results

The means for the three groups on the recall and recognition tests for the Post-test are presented in Table 1 and Figure 1.

Insert Table 1 about here

Insert Figure 1 about here

Analysis (ANOVA) reveled a significant main effect of Group ($p<.05$), but not mode of testing (Recall and Recognition) ($p>.05$) or the interaction of Group*Test ($p>.05$). (Table 2).

Insert Table 2 about here

Analysis of the Group effect indicated that the Rule group was significantly different from the Control Group and from the Discovery Group ($p<.05$), but the Discovery and Control Groups were not different from one another ($p>.05$). No significant difference was found between Recognition and Recall ($p>.05$) for any of the groups.

Discussion

Knowledge of the rule enhanced retrieval of paired associates on the post-test. The enhanced performance was found for both the recall and recognition tests. This finding is consistent with previous studies, (Nosofsky, et al., 1989) but failed to support the response restriction hypothesis proposed by D'Amato and colleagues (D'Amato & Diamond, 1979; D'Amato & Guber, 1982). Their results showed improved performance by the rule-supplied group only on the recall task. Their explanation of the results focused on the fact that knowing the rule did not restrict the number of possible responses on the recognition task, and therefore would not effect the results of the recognition test.

The discrepancy between the findings in D'Amato's work and the present study may stem from the unique nature of the dot/inkprint paired-associates. The Braille dot patterns are arranged in rows of ten, the entire second row of ten letters can be constructed from the first row by adding only one dot. A similar situation exists for the six letters in row three. This reduces the number of paired associates from 26 to 12 (ten first-row pairs and the additional dots for rows two and three). Since all items for the test were presented en masse instead of individually, the subjects could mentally reconstruct the row configurations producing response restriction.

The design of the video demonstration/practice allowed for the possibility that the subjects in group two could discover the rule. Although a small number of subjects did discover the rule (based on written comments), this did not produce a significant difference. The first research hypothesis, which stated that the Rule Group would perform better than either the Discovery or Control Group on the post test was supported for both the recall and recognition tasks.

The results of this study indicate no overall difference between scores on the recall and recognition tests, failing to support the second research hypothesis. This lack of difference is also contrary to the findings of Nosofsky, et al. (1989). One major difference between the present study and most previous research is that all subjects were given both the recall and recognition tests. Typically, research designs have randomly split the subjects into two groups, with the recall and recognition tests given to one, but not both of the groups. It is possible that taking the first test had an effect on the scores of the second test; and that the effect is different depending on which test (recall or recognition) is given first.

Insert Tables 5 & 6 about here

Conclusions

Several areas of future research are suggested by this study. The effect on scores on recall and recognition created by a previous test could be studied with the design of the present study. Since all subjects were tested on both recall and recognition tasks, and the order of testing was randomly reversed, the subjects could be split into two groups based on which test was taken first. Statistical procedures could then be applied to determine if their were significant differences between recall and recognition scores for the two groups.

Students were initially told that they would be tested at the conclusion of the instructional video. It would be expected that knowledge of a future test would have some effect on performance, and knowledge of the type of immediate test may also be a factor. Although Freund, Brelsford and Atkinson (1969) found that differences in recall and recognition did not depend upon whether or not the subject knew the mode of the test to be employed, the development of encoding strategies depending on the type of test may be a factor with other paired associate tasks.

An item analysis, showing number and types of errors, could be used as a basis for several additional studies.There seemed to be fewer recall errors for the first 6-10 letters in the post test. Whether this was due to a primacy effect, the use of fewer dots, or the absence of the lower dots in these letters is not known. Many students where also able to recall the last letters of the alphabet. Further study may show if this was due to a recency effect or the configuration of those letters.

Strategies used to learn the letters, other than the use of the given rule, would also prove an interesting area of research. Several students used related geometric shapes as study aides. The use of these visual schemas may explain the higher number of reversal errors of the sighted students. Several students grouped similar shaped braille and inkprint letters together as a strategy. Rotberg (1964), and Rotberg and Woolman, (1963), studied learning of similar and dissimilar paired associates. It would be possible to analyze the worth of these strategies using data from the present study.

While the results of this study and the use of the braille code do not necessarily suggest application for the teaching of braille to individuals who are blind, some application to the instruction of braille to those with sight, specifically braille transcribers, may be possible. Studies of braille letter and word recognition have shown definite differences in legibility for various braille characters. Ashcroft, (cited in Nolan & Kederis, 1969), found the most common error for individual letters or signs to be missed dots, followed by reversals and added dots. Nolan and Kederis (1969) found that missed dot errors were responsible for 86 percent of the incorrect responses. Character recognition time was also related to the number of dots in a character. Within groups of characters having the same number of dots, those characters with dots most widely dispersed had the shortest recognition time. Characters whose dots fell in the lower two rows of the braille cell required more time for recognition and were missed more frequently than those falling at the top. It would be possible to analyze the data of the present study to determine if subjects with sight made the same type of mistakes. A superficial examination of recall errors suggests that reversals may be a more common mistake with sighted subjects.

The results of this study indicate that providing instruction containing rules will enable subjects to perform better than those not given the rule and expected to discover the rule on their own. In fact, the discovery group did not differ significantly from the group that could not discover the rule. There was no significant difference between the scores on the recall and recognition tasks for the post test. The fact that all subjects were tested for recall and recognition may have influenced this finding.

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Table 1. Summary Statistics for ALL Tests by Group

Group		Recall	Recog	Total
Group 1 Rule	Mean	25.417	25.083	50.506
	S.D.	1.461	2.156	3.220
	Max.	26	26	52
	Min.	20	18	40
Group 2 Discovery	Mean	19.795	20.636	40.386
	S.D.	5.601	5.641	11.048
	Max.	26	26	52
	Min.	7	8	18
Group 3 Control	Mean	18.359	18.949	37.385
	S.D.	4.665	4.594	8.875
	Max.	26	26	52
	Min.	9	11	20

TABLE 2.

TWO-WAY ANALYSIS-OF-VARIANCES SUMMARY COMPARING SCORE BY

GROUP VERSUS MODE (RECALL/RECOGNITION)

SOURCE	SUM-OF SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GROUP	5274.745	2	2637.373	43.135	0.000
MODE	46.837	1	46.837	0.766	0.382
GROUP* MODE	5.465	2	2.732	0.045	0.956
ERROR	28736.698	470	61.142		

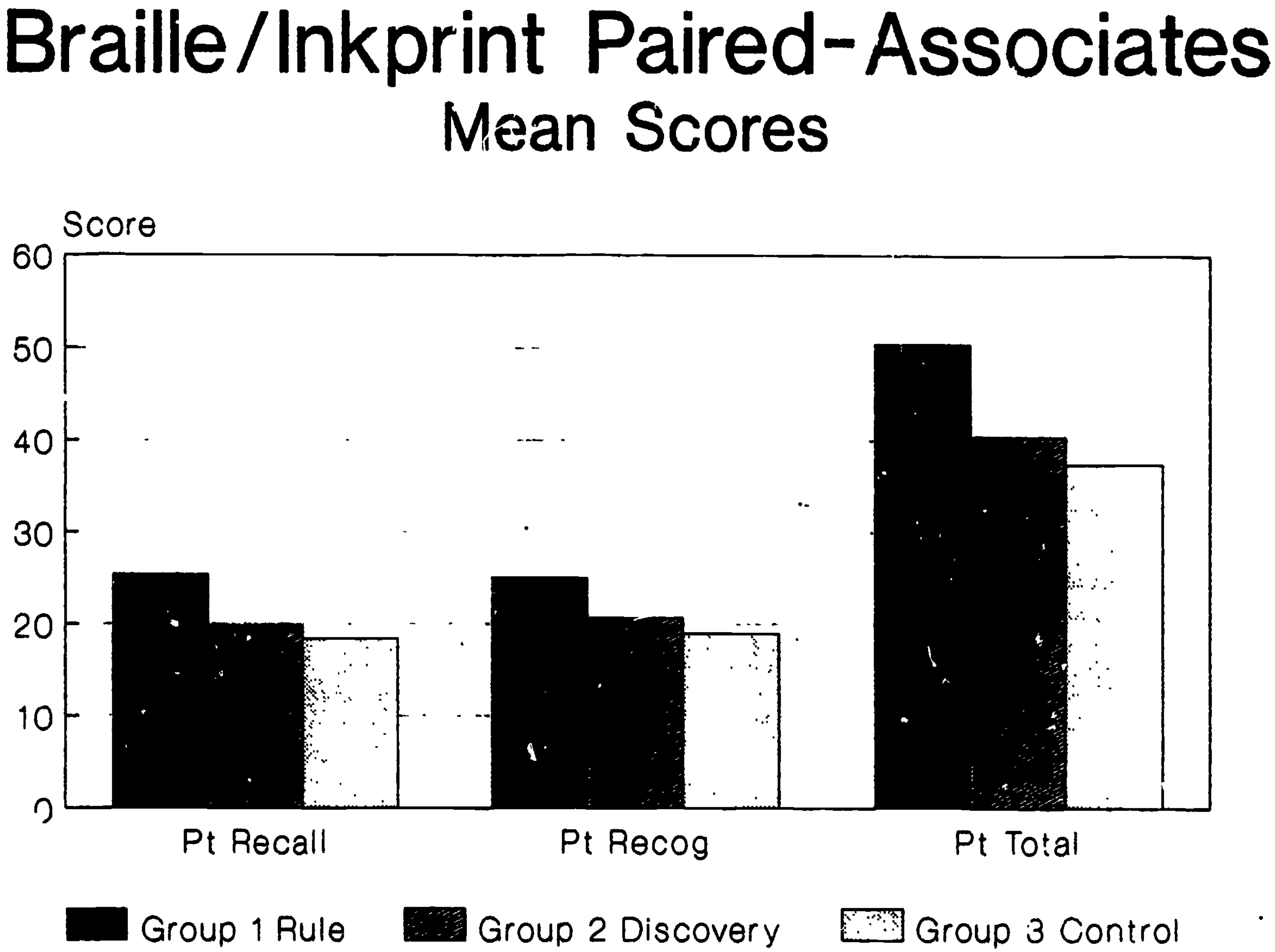
Braille/Inkprint Paired-Associates
Mean Scores
Score
60
50
40
30
20
10
0
Pt Recall
Pt Recog
Pt Total
Group 1 Rule
Group 2 Discovery
Group 3 Control

Figure 1

Student ID Number ____________________

A B C D E F G H I J

K L M N O P Q R S T

U V W X Y Z

Student ID Number ____________________

A B C D E F G

H I J K L M N

O P Q R S T U

V W X Y Z

Student ID Number ____________________ M___ F___ 1 2

Write the braille letter.

M Z P V Y L X W K O

C R J F A I T D N U

E Q H B S G

Student ID Number ____________________ M___ F___ 1 2

Write the inkprint letter.

⠭ ⠝ ⠋ ⠇ ⠟ ⠙ ⠥ ⠕ ⠎ ⠃

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