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EFFECTS OF IMAGERY, MNEMONICS AND LEVEL OF
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EFFECTS OF IMAGERY, MNEMONICS AND
LEVEL OF PROCESSING IN LEARNING DEFINITIONS
UPON CONCEPT COMPREHENSION

by

Craig W. Johnson

A DISSERTATION

Presented to the Faculty of
The Graduate College in the University of Nebraska
In Partial Fulfillment of Requirements
For the Degree of Doctor of Philosophy
Department of Educational Psychology and Measurements

Under the Supervision of Professor Roger Bruning

Lincoln, Nebraska

April, 1978

TITLE

EFFECTS OF IMAGERY, MNEMONICS AND LEVEL OF PROCESSING IN

LEARNING DEFINITIONS UPON CONCEPT COMPREHENSION

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ERRATA

With reference to the within subjects reliability ratings from the norming group of 34, the procedure and results are reported incorrectly on pages 76, 86 & 87, and page 89. The correct procedure and results are as follows:

Procedure

The 34 participants of the second norming group were randomly divided into four subgroups consisting of 8, 9, 9, and 8 participants. Each of these subgroups rated the same random subsample of 25 of the 138 definitions on a different one of the four definitional attributes. The four subgroups above rated Concreteness, Imagery, Comprehensibility and Complexity respectively. Following the rating of the 25 definitions on one of the attributes, participants then rated all 138 definitions on each of the four attributes. First and second ratings of the subsample of 25 were then used to assess test-retest reliabilities for ratings of each of the attributes by computing the correlations between the first and second mean ratings of the 25 definitions, (the 25 items served as subjects).

Results

The within subjects reliabilities of the ratings as determined from the random subsample of 25 of the definitions and the subgroups of 8, 9, 9, and 8 participants were .86, .94, .87 and .89 for Concreteness, Imagery, Comprehensibility and Complexity respectively.

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PREVIEW

CHAPTER I

INTRODUCTION

Statement of Problem

In 1964 John B. Carroll in the Harvard Educational Review explored the relevance of psychological and psycholinguistic theory and experimentation in concept formation to the actual teaching of concepts in the schools. He noted that while some informative and potentially useful outcomes of this research can be found, there are major differences between concept learning in the schools and concept learning as it is studied in the laboratory. School concepts, as he called them, are usually genuinely "new" rather than collections of known concepts like "three circles" or "four squares". School concept attributes represent difficult concepts involving a network of related or prerequisite concepts (e.g., derivative, slope, change of slope, etc.). The attributes are frequently verbal and abstract. Many more difficult concepts of school learning are relational rather than conjunctive. In addition, there must be a mediational process or memory matching of concept labels to concept referents, thus demanding something like paired-associate learning on top of concept learning itself. Finally, most learning of concepts which occurs in schools occurs through a combination of inductive and deductive

procedures. In general, the definitions learned in school are learned through the paradigm of being presented a formal definition with some positive and negative examples. The inductive approach is usually the only one studied in laboratory concept attainment research. Carroll suggests, "we will be better off, however, if concept attainment studies begin to give attention to the manner in which real-life, non artificial concepts can be taught most efficiently -- presumably by combination of both deductive and inductive procedures." (Carroll, 1964; p.193).

General Approach to the Research

The purpose of this study is to pursue Carroll's recommendation. Concepts addressed were appropriate for school learning. They were learned from definitions. The mediational problem of the pairing of concept label and definition was attended to. The concepts tended to be genuinely "new" in Carroll's sense of the term. They also were relational rather than conjunctive. And both verbal abstract and more concrete concept definitions were attended to. The approach to be used was prompted by another suggestion, this time from paired-associate learning research. Rohwer (1970) suggested as a consequence of his research on the effects of verbal and visual elaborative prompts on paired-associate learning that children should be taught the use of both of these kinds of elaborative

activity. Rohwer said that the child "...should be equipped to transform information himself into a form that renders it maximally memorable." (Rohwer, 1970;p.402) .

In this research, college students were explicitly taught strategies for more effective storage and retrieval of information available in definitions. A review of the literature suggested five factors to be theoretically important: (a) level of processing, (Craik and Lockhart, 1972), (b) abstractness-concreteness of the concept definition (Paivio, 1971), (c) mode of coding (i.e., verbal or visual) (Paivio, 1971), (d) associative mediation between concept label and definition (present or absent) (Bower, 1970; Paivio, 1971), and (e) time since learning the definitions.

Four instructional sets were introduced which provided reasonable probabilities of inducing significantly more effective strategies for processing definitions of unfamiliar concepts than those of controls who simply read and copy the definitions. The four instructional sets used verbal and image mnemonics supported by basic research in verbal processing. It was expected that the strategies could be applied to definitional statements in tasks ranging from vocabulary learning to learning of concepts in relatively advanced technical fields given understanding of the component attributes of the newly defined concepts.

The strategies were aimed at achieving the following five objectives: (a) One of the strategies was to have at least a moderate (.50 standard deviation) effect on comprehension performance measured by identifying new instances of newly defined concepts when compared with a control group which only reads and copies the definitions. (b) The strategies were to be quickly learned by most college students by reading a short set of instructions and several examples of the strategy. (c) Strategies were to be applicable to most any course or area of instruction where unfamiliar concepts are encountered. (d) Strategies were to be effective for general vocabulary learning. (e) At least one of the strategies was to be adaptable to use by texts as an instructional aid.

The research represents somewhat of a research and development approach supplemental to the traditional experimental approach to a dissertation. An objective of the study was a product, a strategy or set of strategies, which with some modifications could be used effectively in schools. The research began with the aforesaid objectives. A review of current research was conducted to determine present approaches. An intent was to develop a new strategy which would reasonably accomplish objectives. It was to be tested in a relevant setting. And, there was intention to revise the product to polish and hone it and to put it into operational use, (Borg and Gall, 1971).

Hypotheses

There were three hypotheses to be tested in this study. They were: (a) Will there be a significant interaction between the mode in which the definition is conceptually represented (verbally or visually) and the concreteness of the definitions? (b) Does level of processing (Craik and Lockhart, 1972) of the definition, operationally defined by reading and copying versus reading and writing in terms of the participants own verbal or imaginal constructs, significantly effect recall and comprehension of the definitions? (c) Will the strategies which use keywords (formally prompted associative mediators provided along with the definitions) to help link the concept labels with the definitions result in significantly superior recall and comprehension performance? To test these hypotheses comprehension was assessed by identification of new instances of the concepts.

The following review of research and accompanying logic suggested that this research would achieve its objectives. It presents a theoretical position which combines multicode (Paivio, 1971) and multilevel, (Craik and Lockhart, 1972) information processing positions with the relational organization orientation of Bower (1970). Differential effectiveness of the instructional sets was predicted from these theoretical bases.

CHAPTER II

REVIEW OF THE LITERATURE

Coding Processes

Dual and Multistore Models of Memory

Allan Paivio (1971) has formulated a dual-coding hypothesis for memory. Essentially, this hypothesis states that there are primarily two modes for processing information, the verbal mode and the visual or imagery mode. These two modes operate in essentially complementary fashion so that when information is coded in both modes memory for information will be better. According to Paivio, "... Analysis implies that both codes can be functional in tasks involving retention of item information, since even in free verbal recall the appropriate verbal response presumably can be retrieved from either code provided that the image can be readily decoded. The probability of remembering an item would thus be a direct function of the availability of both codes. In effect, this is a CODING REDUNDANCY hypothesis: Memory increases directly with the number of alternative memory codes available for an item." (Paivio, 1971; p. 181). Thus, in the case of imagery the increase in number of items remembered as one goes from abstract to concrete words to pictures will be a function of the differential availability

of the image code for the more highly concrete items.

The imagery coding system is essentially a parallel-processing system, while the verbal code is essentially a serial processing system by virtue of the temporal nature of the auditory-motor speech system. Another primary tenet of this theoretical viewpoint is the following, "inasmuch as the imaginal and verbal codes are functionally differentiated in the theory primarily in terms of their relative efficiency as spatial and sequential information processing systems, the greatest differential effects should occur in tasks involving memory for spatial as compared to sequential information." (Paivio, 1971; p. 181). This being the case, it might be expected that if verbal abstract information can be coded into the image code recall of such information might be substantially facilitated if the coding and decoding problems can be solved.

In a further analysis of the role of imagery in learning and memory Paivio (1972) lists three encoding factors (a) item concreteness (b) instructional set and (c) presentation rate and five storage and retrieval factors (a) vividness (b) redundancy (c) organizational processes (d) interference and distinctiveness and (e) retrieval mechanisms related to attributes of effective retrieval cues. These factors are presumed to be of primary importance in learning and memory. Of these factors, item concreteness, instructional set, organizational processes

and retrieval mechanisms were varied experimentally in this study.

In another approach to the topic of imagery, Neisser (1972) has attempted to clarify the nature of images by differentiating them from mental pictures. He refers to imagery as a quasiperceptual process and images as mental layouts and presents experimental evidence to support this.

A third approach, that of Lindauer (1972), has stressed the importance of recognizing many sensory modalities for imagery along with their differential characteristics with respect to free recall of sensory words. Visual and auditory modes were not found to be the highest in imagery nor the best in recall in his studies. In fact, gustatory and olfactory modes were higher in both.

The point is that there is now recognition among some respected researchers of a multimodal or multicode nature for information processing. Unique characteristics of the various modes or codes need attending to in memory research and have relevance for the retention of concepts learned from definitions.

The two coding systems of concern for this research are the imaginal system and the verbal system. Thus characteristic effects related to the dual-coding hypothesis from free recall and paired-associate studies will now be reviewed with a view to extension of results to definitional learning.

Implications of the Dual Coding Hypothesis for Free Recall and Paired Associate Learning

Historical note. According to Paivio (1971), the earliest experimental study on the effects of imagery instructions was a free recall experiment by Kirkpatrick (1894). In one part of this study 10-item lists of concrete nouns were presented to subjects with or without instructions to form a mental picture of the objects named. The result, replicated in two studies, was that recall was slightly but consistently better under the imagery instructions. In one experiment, the immediate mean recall scores for 379 participants (ranging in age from elementary school to college level) were 6.85 and 7.48 for no imagery and imagery conditions, respectively; in another, the respective means for 180 students were 7.33 and 8.01. Recall after three days for the latter group was more markedly influenced by the imagery instructions, the means being 2.61 and 4.22 for no imagery and imagery conditions.

This early study not only provided evidence for superiority of the image code in immediate recall, but suggested superiority in delayed recall as well. Since that time, additional support has been found for the hypothesis that the image code is more resistant to decay. Bower, in a summary of research attending to that question, says, "The data suggest that the imagery code (or tag) has a slower decay rate than the verbal code." (cf. Bower, 1970, p.84;

Begg & Robertson, 1973).

Although imagery as an object of experimental investigation was largely ignored or neglected for a considerable period of time, the work of Paivio and his associates at the University of Western Ontario has been a major force in the reassertion of this field of inquiry as a legitimate topic of experimental investigation. Many of Paivio's earlier studies focused on the establishment of strong correlative relationships between imagery values of items (established by the Paivio, Yuille and Madigan (1968) norms) and paired-associate and free recall performance. Others focused on comparing reaction time latencies for abstract and concrete items given verbal and image instructional sets.

The pivotal reaction time data of Paivio (1966) showed that the latency of an associated image to a stimulus word was longer when the word was abstract than when it was concrete, whereas verbal associative latency was less affected by variation in concreteness. This result provided early evidence for the dual coding hypothesis.

In a 1968 factor-analytic study of word attributes and verbal learning Paivio attempted to tease out variables correlating with item concreteness to determine what attributes correlate most highly with paired-associate learning and free recall. The highest correlations were those between the three imagery variables and PA learning

scores when the items were in the stimulus position. Paivio concluded that this study showed that imagery was uniquely effective in the paired-associate learning of nouns, surpassing numerous other variables including concreteness and meaningfulness.

Later, Paivio (1970) found that imagery value (I) correlated more highly than meaningfulness (m) with learning scores in paired-associate learning. Superiority of I over m was greatest when the items were on the stimulus side. Paired associate learning correlated .54 with stimulus I and .31 with response I ($p < .01$). For m the correlations were .37 and .21 respectively. Correlations with free recall were .32 and .17 for I and m respectively with only the first significant. Partialing out I (I and m correlated .69) reduced correlations to zero for both stimulus and response scores' m's. However, when m was partialled out, correlations were still significant. Paivio concluded that the data supported word imagery as a potent variable in verbal learning and furthermore, that the superiority of imagery over other attributes as a predictor of learning is greatest within the paired associate situation with attributes varied on the stimulus side.

Implications of dual-coding. These findings, along with others such as Paivio, Yuille and Madigan (1968), where it was noted that many items were low in imagery and concreteness and high in meaningfulness, provided further

support for the dual coding hypothesis.

Two immediate consequences of this position are stated in the following hypotheses: (a) As items become more concrete and thus the image code becomes more available in addition to the verbal code, memory for these items should improve. (b) An imagery instructional set should facilitate the paired-associate recall of concrete noun pairs while it interferes with the recall of abstract noun pairs when compared with a verbal instructional set.

In reference to the latter hypothesis, a study designed to determine whether imagery instructions facilitated learning high I pairs and interfered with learning low I pairs and to determine whether verbal mediation instructions would be particularly facilitative with high m pairs was conducted by Paivio and Yuille (1967). They found that both verbal mediation and imagery instructional sets were superior to repetition, but the predicted interaction was not obtained. The general import of the mediation data was, however, that instructions were not uniformly adhered to. The reported use of imagery was determined more by the item attributes than the instructional sets.

A master's thesis by Rogers (1967) indicated that recall was facilitated for abstract nouns under imagery instructions, but not for concrete nouns. Conversely, Gupton and Frincke (1970) found that imagery instructions facilitated free recall for noun-verb pairs when the imagery

value of the nouns was high, but not when it was low.

Paivio (1971) believed that the empirical inconsistencies represented in these studies could probably be attributed to differences in the items and procedures used in these experiments. It seemed that the problem in confirming the elusive interaction predicted in the second hypothesis above was likely a methodological one having to do with ineffective experimental control of participants processing activities and this was not an easy one to solve.

The interaction was finally confirmed by Paivio and Foth (1970) in an experiment in which participants were literally forced to encode paired-associate items appropriately. Using concrete and abstract noun pairs within-Ss, participants were required to generate image drawings or write phrases, where instructional set was varied item by item. With this degree of experimental control the expected disordinal interaction of instructional set and pair concreteness was confirmed. The image set was superior on concrete pairs. The verbal set was superior on abstract pairs.

A modified generalization of this hypothesis was tested in this research. Items were concept labels and their definitions instead of noun pairs. The concreteness of the definitions was varied, with the image set again expected to be superior on the concrete definitions and the verbal set expected to be superior on the abstract definitions. A high

degree of experimental control was assured with a procedure similar to Paivio and Foth's, requiring participants to write out representations of processing codes.

As a conclusion for the research cited above Neisser (1970) has written some comments which seem appropriate. "It turns out that concrete vivid nouns are easier to remember than abstract ones. This has been shown for paired-associates by Allan Paivio and his collaborators at Western Ontario (Paivio, 1965; Paivio, Yuille and Smythe, 1966; Paivio and Madigan, 1968) and for free recall by Tulving, McNulty, and Ozier (1965) at Toronto. The mnemonic superiority of easily picturable words (for this is what the experiments are dealing with) is thus firmly established" (Neisser, 1970; p.167).

One other line of related research is relevant to the above effects. Sheehan (1972) has investigated the role of imagery in incidental versus intentional learning of concrete and abstract nouns matched in meaningfulness and familiarity. His results generally consistently replicate the effect that more concrete as compared with abstract nouns are recognized under incidental than intentional instructional sets. The effect did not occur with non-vivid imagers. And, it did not occur on recall. However, this suggested an imagist oriented recognition theory, according to Sheehan, with incidental learning more likely to benefit from imagery than intentional learning. The implication for