DOCUMENT RESUME

ED 092 905 CS 001 178

AUTHOR	Levin, Joel R.; And Others
TITLE	Picture-Word Differences in Discrimination Learning: I. Apparent Frequency Manipulations.
INSTITUTION	Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C.
REPORT NO	TR-253
PUB DATE	May 73
CONTRACT	NE-C-00-3-0065
NOTE	13p.; Report from the Research Component "Children's Learning and Development"
EDRS PRICE	MF-$0.75 HC-$1.50 PLUS POSTAGE
DESCRIPTORS	*Discrimination Learning; Grade 6; *Learning; Pictorial Stimuli; Reading; *Reading Processes; *Reading Research; Reading Skills; Visual Discrimination; Word Recognition

ABSTRACT

This experiment was a direct test of the hypothesis that picture-word differences in discrimination learning are a function of apparent frequency differences associated with two types of material. The subjects consisted of 80 sixth graders randomly selected from two elementary schools located in middle-class neighborhoods. Each subject was tested individually by the experimenter, who presented either a pair of pictures or words which differed either substantially or minimally in apparent frequency measures. Each pair was shown for three seconds and then the same pair was immediately shown again for three seconds with the correct member indicated by an asterisk placed below it. The results indicated that while the usual pricture-over-word effect was found when picture-word apparent frequency differences were large, it vanished when pictures and words were equated in terms of apparent frequency. (WR)

Technical Report No. 253

PICTURE-WORD DIFFERENCES IN DISCRIMINATION LEARNING: I. APPARENT FREQUENCY MANIPULATIONS

by

Joel R. Levin, Elizabeth S. Ghatala,

and Larry Wilder

Report from the Research Component
Children's Learning and Development

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
Madison, Wisconsin

May 1973

Statement of Focus

Individually Guided Education (IGE) is a new comprehensive system of elementary education. The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. The development of other curriculum components, of a system for managing instruction by computer, and of instructional strategies is needed to complete the system. Continuing programmatic research is required to provide a sound knowledge base for the components under development and for improved second generation components. Finally, systematic implementation is essential so that the products will function properly in the IGE schools.

The Center plans and carries out the research, development, and implementation components of its IGE program in this sequence: (1) identify the needs and delimit the component problem area; (2) assess the possible constraints—financial resources and availability of staff; (3) formulate general plans and specific procedures for solving the problems; (4) secure and allocate human and material resources to carry out the plans; (5) provide for effective communication among personnel and efficient management of activities and resources; and (6) evaluate the effectiveness of each activity and its contribution to the total program and correct any difficulties through feedback mechanisms and appropriate management techniques.

A self-renewing system of elementary education is projected in each participating elementary school, i.e., one which is less dependent on external sources for direction and is more responsive to the needs of the children attending each particular school. In the IGE schools, Center-developed and other curriculum products compatible with the Center's instructional programing model will lead to higher student achievement and self-direction in learning and in conduct and also to higher morale and job satisfaction among educational personnel. Each developmental product makes its unique contribution to IGE as it is implemented in the schools. The various research components add to the knowledge of Center practitioners, developers, and theorists.

Acknowledgments

We are grateful to Billie Albrecht and Diane Eich for preparing the final draft of the paper. The basis for determining the order of the first two authors was random. Dr. Ghatala is now at Weber State College, Ogden, Utah.

Table of Contents

List of Tables and Figures

Abstract

A discrimination learning task was administered to a sample of sixth graders. Stimulus materials consisted of either pictures or words for which frequency judgments had been obtained in a previous experiment. Picture and word items were selected which differed either substantially or minimally in apparent frequency measures. While the usual picture-over-word effect was found when picture-word apparent frequency differences were large, it vanished when pictures and words were equated in terms of apparent frequency. These results, coupled with some recent data, provide for a fairly complete account of picture-word differences in discrimination learning.

I
Introduction

Recently it has been demonstrated that both children (Rowe, 1972; Wilder & Levin, 1973) and adults (Rowe, 1972; Rowe & Paivio, 1971; Wilder & Levin, 1973) learn pictures more easily than words in a discrimination task. To date, one of the more popular explanations of this effect has been that pictures are more likely than words to produce a simultaneous verbal-imaginal encoding, and that dually-coded materials are better recalled (Paivio, 1971). However, guided by the frequency theory of verbal discrimination learning originally proposed by Ekstrand, Wallace, and Underwood (1966), we conducted an experiment which suggested that picture-word effects in discrimination learning may be attributable to differences in the subjective (apparent) frequency associated with the two types of material (Ghatala, Levin, & Wilder, 1973).

In that experiment sixth graders were administered either a picture or word frequency judgment task in which line drawings of familiar objects or their printed verbal labels were presented for varying numbers of exposures, with Ss later asked to estimate the number of times a particular picture or word had been previously shown. We found that the mean judgments for pictures were higher than the mean judgments for words even though the actual presentation frequencies of the two were the same. In addition, we found that the average variability associated with items of the same presentation frequency was lower for pictures than for words.

According to frequency theory, discrimination between the "correct" and "incorrect" members of a pair in a verbal discrimination task is based on the frequency differential between the two, with more subjective frequency "units" accruing to the correct member of the pair than to the incorrect member through such factors as differential rehearsal favoring the former. The Ghatala et al. (1973) results are consistent with a frequency theory interpretation of picture-word differences in discrimination learning since (a) the finding that pictures were higher in mean apparent frequency than words suggests that a subjective frequency "unit" produced by a picture is larger than a frequency "unit" produced by a word; and (b) the finding that Ss were less variable in estimating the presentation frequencies of pictures as compared to words suggests that differences in presentation frequency are more likely to be discriminated when the items are pictures than when they are words. Both findings lead to the prediction that discrimination learning will be superior when the materials are pictures: the first, because the absolute frequency difference between correct and incorrect items is larger for picture pairs than for word pairs; the second, because lower variability associated with correct and incorrect items in picture pairs renders them more discriminable than word pairs.

The present experiment was a direct test of the hypothesis that picture-word differences in discrimination learning are a function of apparent frequency differences associated with the two types of material. How apparent frequency judgments were obtained, and how they were manipulated, is discussed in the following section.

II
Method

Design and Materials

In the Ghatala et al. (1973) study, 19 sixth-grade Ss judged the frequencies of 39 pictures which had been presented from one to four times. Another 19 Ss gave frequency judgments for the corresponding printed labels.

Manipulation of Apparent Frequency Means

Comparing the mean apparent frequencies of individual picture and word items, we found that the mean of pictures was reliably higher ($p < .001$). However, while in general the mean judgments of pictures (at each presentation frequency) were higher than those of words, there was some overlap in the two distributions. In particular, 14 of the pictures could be matched fairly closely with 14 of the words. From these items were formed seven picture pairs and seven word pairs which differed minimally in mean apparent frequency (small-difference items). Next, 14 pictures and 14 words were selected to form seven picture pairs and seven word pairs which differed considerably in mean apparent frequency (large-difference items).

The summary statistics for these picture and word pairs are shown in the upper portion of Table 1. The first row of Table 1 indicates that for small-difference items the mean apparent frequencies of pictures and words (averaged over the 14 pictures and 14 words) are the same (the average difference between pictures and words equals .00). On the other hand, the second row of Table 1 shows picture and word pairs with large differences (average = .58) in mean apparent frequency.

The 14 picture pairs (seven small-difference items plus seven large-difference items) comprised one discrimination list, and the 14 word pairs comprised another. In forming each list an attempt was made to equate a pair's "correct and "incorrect" members in apparent frequency. This was done in order to ensure that any between-materials (pictures and words) apparent frequency differences were manipulated independently of within-materials (correct and incorrect members) apparent frequency differences.

Three presentation orders of each list were constructed such that: (a) within each order the occurrence of small- and large-difference items was random; (b) within an order the correct member was located on the right for half the pairs and on the left for the other half; and (c) across orders the spatial location of the correct member of each pair was varied randomly with the restriction that it could not occur in the same position across all three orders. The randomization scheme for constructing the three presentation orders was the same for picture and word lists--i.e., each order's sequence of small- and large-difference items, as well as its spatial location of correct members, was the same for the two lists.

The pictures were line drawings (3" x 3") which were pasted side by side on sheets of 8-1/2" x 11" paper. The sheets were then placed in a three-ring notebook binder. The words were typed in primary type, side by side, on sheets of paper which were placed in a separate three-ring binder. Asterisks were used to indicate the correct member in each pair.

Manipulation of Apparent Frequency Variances

From the same pool of items used to construct lists varying in mean apparent frequency, picture and word items were selected on the basis of the variance in apparent frequency associated with each item. The variance of these judgments differed for pictures and words, being statistically smaller for pictures

($p < .001$). Once again, there was some overlap between the two distributions. As may be seen in the lower portion of Table 1, small-difference items were constructed from 14 pictures and 14 words which differed little in variability (average difference = .02), while large-difference items consisted of 14 pictures for which the variability was substantially lower than that of 14 selected words (average difference = .41).

As before, the seven small-difference and seven large-difference items within each stimulus type were combined to form a 14-pair picture list and a 14-pair word list. The procedures used in creating the lists were the same as those previously described.

Finally, it should be noted that in selecting items to investigate one of the measures of apparent frequency (either means or variances) an attempt was made to control the other measure, even though this could not be done perfectly. For example, the average variance of picture and word items selected for a small difference in mean judgments was .45 and .65, respectively. For large-difference items these figures were .55 and .61. With regard to items selected for small differences in variance the mean apparent frequency for picture pairs was 1.64 and for word pairs it was 1.40. For the items with large variance differences the corresponding means were 1.49 and 1.41.

Subjects

The Ss were 80 sixth-grade children (mean age = 12.4 years) randomly selected from two elementary schools located in middle-class neighborhoods in Ogden, Utah. Twenty Ss were assigned (according to a block-randomized procedure) to each of the four conditions formed by the combination of two materials (pictures or words) and two measures (means or variances). The number of Ss required followed directly from the simultaneous specification of effects considered important and those considered trivial (Walster & Cleary, 1970).

Procedure

Each S was tested individually in a small private room in the school building. The S was seated beside E who presented the pairs in the list by turning the pages in the appropriate notebook. Each pair was shown for three seconds (timed by a stopwatch), and then the same pair was immediately shown again for three seconds with the correct member indicated by an asterisk placed below it. Each S received one study trial, during which he did not respond, followed by two anticipation trials. The intertrial interval was five seconds. Conventional verbal discrimination instructions for the anticipation procedure were given.

TABLE 1
APPARENT FREQUENCY DATA ON PICTURE AND WORD PAIRS

	Pictures	Words
Average of Item Means		
Small-difference items	1.42	1.42
Large-difference items	1.74	1.16
Average of Item Variances	Pictures	Words
Small-difference items	.54	.52
Large-difference items	.39	.80

III
Results and Discussion

Performance on the discrimination task is summarized in Figure 1. For both mean and variance manipulations the results are clear-cut: with large-difference items pictures and words differ substantially (means: F = 13.58, df = 1/38, p < .001; variances: F = 6.48, df = 1/38, p < .05), whereas with small-difference items they do not (means: F < 1; variances: F < 1). While there was marked improvement over trials, in no cases did this interact with the above picture-word effects (all p's > .05).

Based on the assumption that discrimination learning consists of discriminations of subjective frequency differences between items (Ekstrand et al., 1966), and given the empirical finding that apparent frequencies associated with pictures and words differ (Ghatala et al., 1973), we were able to anticipate the usual picture-over-word superiority in discrimination learning (Rowe, 1972; Rowe & Paivio, 1971; Wilder & Levin, 1973) when apparent frequency differences between pictures and words were maintained. On the other hand, when pictures

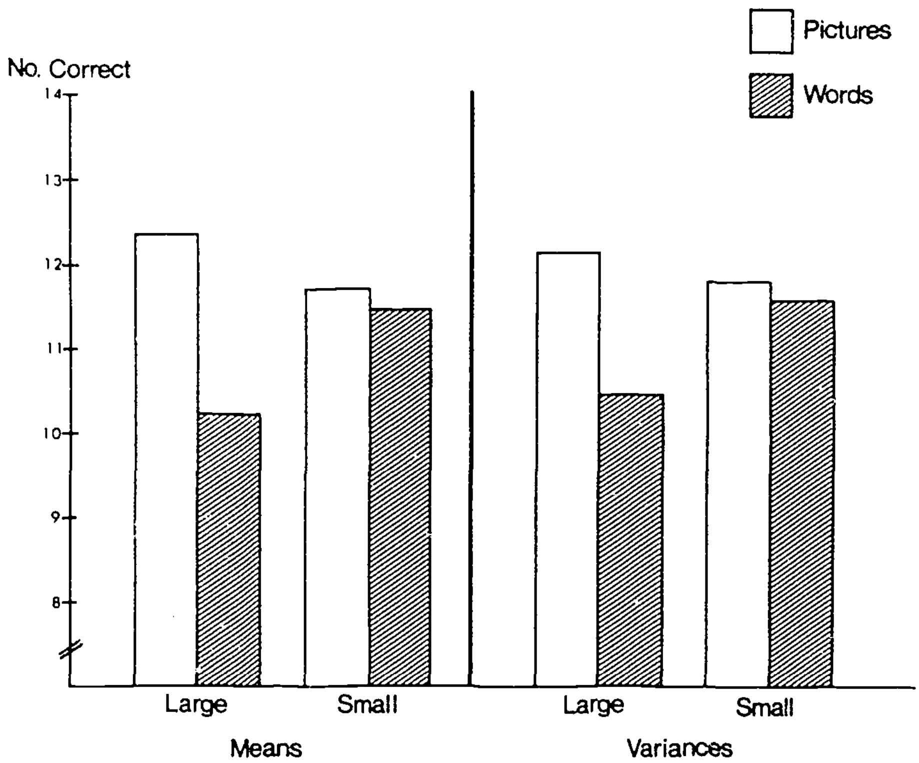

Fig. 1. Mean number of correct discriminations in two trials on items with large or small mean and variance differences (maximum score = 14).

and words were equated in terms of either apparent frequency means or variances (as determined from an earlier study), no discrimination learning differences between the two types of material were detected.

While it is not possible to state with certainty which of the two measures, means or variances, has the more predominant influence on picture-word differences in discrimination learning (since the two measures covary, and this problem was not completely controlled for here), we are able to speculate on the basis of some previous research. In one published study (Ghatala & Levin, in press) and in another unpublished study we have found that pictures and words differ more reliably with respect to variability in apparent frequency (pictures being lower) than with respect to mean apparent frequency. If this result continues to be replicated in further controlled experiments, it would indicate that pictures are easier to discriminate than words because the subjective frequency units associated with them are more stable.

To explain picture-word differences in discrimination learning in terms of apparent frequency differences may seem no more appealing than to explain them in terms of previously offered constructs (e.g., concreteness/dual coding, meaningfulness, encoding variability, and the like). For example, it might be argued that pictures have greater apparent frequency than words simply because they are more concrete, and it is this concreteness attribute which is responsible for <u>both</u> increased apparent frequency and improved discrimination learning performance. Although we have not conducted a systematic examination of our present materials, it is hard to believe that in manipulating apparent frequency differences of pictures and words, we were simultaneously manipulating differences in concreteness, meaningfulness, and so forth.

We prefer a frequency theory (Ekstrand et al., 1966) explanation of these effects on the basis of scientific parsimony (in particular, with regard to the operationalization of the manner and contexts in which frequency "units" accrue). We are well aware that the validity of an "apparent frequency" construct is not enhanced unless one can explain <u>why</u> pictures and words differ in apparent frequency. However, such an attempt has recently been made by Ghatala et al. (1973).

Essentially the argument is that pictures and words differ substantially in terms of <u>S</u>'s pre-experimental encounters with them. Thus while <u>S</u>s have likely read the experimental words on numerous pre-experimental occasions, they have never encountered (pre-experimentally) the particular experimental line drawings. By adapting Weber's law to this type of situation, it is readily understandable why the presentation of a picture (initially low in pre-experimental exposure) should constitute a larger--and evidently more stable--subjective frequency unit than the presentation of a word (initially high in pre-experimental exposure). Based on this rationale, some interesting predictions can be made (and in fact, have been made--cf. Ghatala & Levin, in press) regarding developmental trends associated with picture-word differences.

Certainly there are additional verbal discrimination and recognition memory phenomena with which the "background frequency" explanation must deal before it can be considered viable. Whether or not it can negotiate them successfully remains to be seen.

References

Ekstrand, B. R., Wallace, W. P., & Underwood, B. J. A frequency theory of verbal-discrimination learning. Psychological Review, 1966, 73, 556-578.

Ghatala, E. S., & Levin, J. R. Developmental differences in frequency judgments of words and pictures. Journal of Experimental Child Psychology, in press.

Ghatala, E. S., Levin, J. R., & Wilder, L. Apparent frequency of words and pictures as a function of pronunciation and imagery. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 85-90.

Paivio, A. Imagery and verbal processes. New York: Holt, 1971.

Rowe, E. J. Discrimination learning of pictures and words: A replication of picture superiority. Journal of Experimental Child Psychology, 1972, 14, 303-312.

Rowe, E. J., & Paivio, A. Discrimination learning of pictures and words. Psychonomic Science, 1971, 22, 87-88.

Walster, G. W., & Cleary, T. A. Statistical significance as a decision-making rule. In E. F. Borgatta & G. W. Bohrnstedt (Eds.), Sociological methodology. San Francisco: Jossey-Bass, 1970.

Wilder, L., & Levin, J. R. A developmental study of pronouncing responses in the discrimination learning of words and pictures. Journal of Experimental Child Psychology, 1973, 15, 278-286.

GPO 803-821-3

National Evaluation Committee

Helen Bain
Immediate Past President
National Education Association

Lyle E. Bourne, Jr.
Institute for the Study of Intellectual Behavior
University of Colorado

Jeanne S. Chall
Graduate School of Education
Harvard University

Francis S. Chase
Department of Education
University of Chicago

George E. Dickson
College of Education
University of Toledo

Hugh J. Scott
Superintendent of Public Schools
District of Columbia

H. Craig Sipe
Department of Instruction
State University of New York

G. Wesley Sowards
Dean of Education
Florida International University

Benton J. Underwood
Department of Psychology
Northwestern University

Robert J. Wisner
Mathematics Department
New Mexico State University

Executive Committee

William R. Bush
Director, Program Planning and Management
Deputy Director, R & D Center

Herbert J. Klausmeier, Committee Chairman
Principal Investigator
R & D Center

Joel R. Levin
Principal Investigator
R & D Center

Donald J. McCarty
Dean, School of Education
University of Wisconsin

Richard A. Rossmiller
Director
R & D Center

Dan Woolpert
Director, Management Systems
R & D Center

ɩculty of Principal Investigators

Vernon L. Allen
Professor
Psychology

Frank H. Farley
Associate Professor
Educational Psychology

Marvin J. Fruth
Associate Professor
Educational Administration

John G. Harvey
Associate Professor
Mathematics

Frank H. Hooper
Associate Professor
Child Development

Herbert J. Klausmeier
V. A. C. Henmon Professor
Educational Psychology

Stephen J. Knezevich
Professor
Educational Administration

Joel R. Levin
Associate Professor
Educational Psychology

L. Joseph Lins
Professor
Institutional Studies

James Lipham
Professor
Educational Administration

Wayne Otto
Professor
Curriculum and Instruction

Robert Petzold
Professor
Curriculum and Instruction

Thomas A. Romberg
Associate Professor
Curriculum and Instruction

Richard A. Rossmiller
Center Director
Professor, Educational Administration

Richard L. Venezky
Associate Professor
Computer Science

Alan M. Voelker
Assistant Professor
Curriculum and Instruction

Larry M. Wilder
Assistant Professor
Communication Arts