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EFFECTS OF CONGRUENT AND INCONGRUENT CONTEXTUAL CUES
ON THE LEARNING AND RETENTION OF PAIRED-
ASSOCIATES

by Clarence J. Jeffrey

Thesis presented to the Faculty of
Education of the University of Ottawa
as partial fulfillment of the requirements
for the degree of Ph.D. in Educational
Psychology



Ottawa, Canada, 1969

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ACKNOWLEDGMENTS

This thesis was prepared under the supervision of Professor Raymond Vaillancourt, Ph.D., of the Faculty of Psychology of the University of Ottawa.

The author is also indebted to the personnel and students of the School of Nursing of the same institution for their complete collaboration in the realization of this project.

CURRICULUM STUDIORUM

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INTRODUCTION

A fair amount of studies have been directed towards stimulus selection in paired-associate and serial learning situations. The general procedure is to present two cues simultaneously and to test later to see which cue has been functional. To this end, experimenters have utilized cues such as words, shapes, colors, letters or numbers. Studies have dealt mainly with the effects of adding, subtracting and changing these cues. Few studies have been concerned with the effects of several cues, and not one, as known to the author, has examined the effects, if any, of consonant and dissonant combinations. The present thesis is a report of an attempt to explore the latter area through an investigation of the effects of congruent and incongruent contextual cues on the learning and retention of paired-associates.

From a review of the literature, sources of the hypotheses are stated and general hypotheses formulated. Chapter Two describes the sample, design, materials and procedures utilized to test the hypotheses. The dependent measures are stated and analytical procedures outlined. The presentation of results, Chapter Three, is divided according to the two phases of the experiment: the learning phase and the recall and relearning phase. A Fourth Chapter,

the discussion of results, is complemented by a summary and conclusion in which educational implications are considered and further research is suggested.

CHAPTER I

REVIEW OF THE LITERATURE

The stimulus selection hypothesis predicts that when a complex stimulus is presented to a subject a selection process occurs so that the effective cue for response elicitation in paired-associates is some component of the complex stimulus that is actually presented.¹ The existence of such a phenomenon had been previously inferred by Weiss and Margolius² on context experiments in which removal of a component from a compound stimulus produced a decrement in recall. Underwood, Ham and Ekstrand³ have consequently made a distinction between the nominal stimulus (the stimulus actually presented S) and the functional stimulus (the component of the nominal stimulus which becomes the effective cue for response elicitation).

1 Benton J. Underwood, "Stimulus Selection in Verbal Learning", in C. N. Cofer and B. S. Musgrave, (eds.). Verbal Behavior and Learning: Problems and Processes, New York, McGraw-Hill, 1963, p. 33-47.

2 Walter Weiss and Garry Margolius, "The Effect of Context Stimuli on Learning and Retention", Journal of Experimental Psychology, Vol. 48, No. 5, 1954, p. 318-322.

3 Benton J. Underwood, Margaret Ham and Bruce Ekstrand, "Cue Selection in Paired-Associate Learning", Journal of Experimental Psychology, Vol. 64, No. 4, 1962, p. 405-409.

1. Stimulus Selection Experiments.

Various investigations have served to substantiate the "stimulus selection" or "fractionation" hypothesis. Jenkins⁴ demonstrated fractionation with non-overlapping consonant trigram stimuli and numerals as responses. When the pairs had been learned, individual letters were presented and subjects were required to respond with the appropriate number. Responses to letters which had been in the initial and final positions in the trigrams were correct significantly more often than responses to medial letters. The results supported the hypothesis that subjects learn to respond to only part of the stimulus compound. It was additionally shown by Jenkins and Bailey⁵ that directing subject's attention to the more difficult portion of the stimulus compound by requiring him to read the trigrams aloud had no significant effect on the choice of the selected

4 James J. Jenkins, "Stimulus Fractionation in Paired-Associate Learning", Psychological Reports, Vol. 13, No. 2, 1963, p. 409-410.

5 James J. Jenkins and Virginia B. Bailey, "Cue Selection and Mediated Transfer in Paired-Associate Learning", Journal of Experimental Psychology, Vol. 67, No. 1, 1964, p. 101-102

component in transfer. Rabinowitz and Witte⁶ further explored this attentional value by studying the interactive effect of having one of the three letters of the trigram colored red. Subjects exhibited a tendency to use the initial letters as functional stimuli, even when the second or third letter is red. The data indicated that subjects use a single distinctive element of a multiple-element nominal stimulus as the functional stimulus.

A second inference, derived from the stimulus selection hypothesis, is that the omission of context elements during recall should lead to a performance decrement functionally related to the amount of element-sharing in the stimulus. Such an hypothesis was tested by Newman and Taylor.⁷ The number of consonants shared by CVC stimulus terms was varied into a High Sharing List and a Low Sharing List. Each stimulus term of the list appeared on a different color background with single-digit response terms on white backgrounds. During recall, half of the subjects

6 F. Michael Rabinowitz and Kenneth L. Witte, "Stimulus Selection as a Function of Letter Color", Journal of Verbal Learning and Verbal Behavior, Vol. 6, No. 1, 1967, p. 167-168.

7 Slater E. Newman and L. Rogers Taylor, "Context Effects in Paired-Associate Learning as a Function of Element-Sharing among Stimulus Terms," Journal of Verbal Learning and Verbal Behavior, Vol. 1, No. 4, 1963, p. 243-249.

in both groups were tested with stimulus terms presented on white backgrounds. The results indicated that selection of contextual cue was a direct function of the number of primary elements shared by the term with other stimulus terms in the list. The higher performance of the "no change group" than of the "change group" on recall tests agrees with the results of other context-cue experiments, namely, Sundland and Wickens,⁸ Underwood⁹ and Weiss and Margolius,¹⁰ indicating that, when context elements are omitted on recall, performance declines. In the Newman and Taylor¹¹ experiment it was also concluded that, after learning a list of paired-associates with complex stimuli, there are cases in which subjects can give correct responses to one stimulus element but not to another. This conclusion likewise agrees with the results obtained by Jenkins and

8 Donald M. Sundland and Delos D. Wickens, "Context Factors in Paired-Associate Learning and Recall", Journal of Experimental Psychology, Vol. 63, No. 3, 1962, p. 302-306.

9 Underwood, Op. Cit.

10 Weiss and Margolius, Op. Cit.

11 Newman and Taylor, Op. Cit.

Bailey,¹² Cohen and Musgrave,¹³ and Houston.¹⁴ The generalization to be derived is that associations between responses and components of compound stimuli can be of differing strengths despite equal opportunities for practice.

The preceding reports, substantiating the stimulus selection hypothesis, utilized designs which involved measurements of S-R associations. Evidence has also been acquired from studies employing R-S paradigms.

Jantz and Underwood¹⁵ have shown that R-S or backward learning is a direct function of both meaningfulness of stimuli during S-R learning and the degree of S-R learning. Measurements of R-S learning derived from recall and from transfer effects yielded essentially the same results. Subjects' R-S associations were found to be related to the functional component of the stimulus compound. In a somewhat comparable experiment, support to the hypothesis

12 Jenkins and Bailey, Op. Cit.

13 Jean C. Cohen and Barbara S. Musgrave, "Effects of Meaningfulness on Cue Selection in Verbal Paired-Associate Learning", Journal of Experimental Psychology, Vol. 68, No. 3, 1964, p. 284-291.

14 John P. Houston, "S-R Stimulus Selection and Strength of R-S Association", Journal of Experimental Psychology, Vol. 68, No. 6, 1964, p. 563-566.

15 Eleanore M. Jantz and Benton J. Underwood, "R-S Learning as a Function of Meaningfulness and Degree of S-R Learning", Journal of Experimental Psychology, Vol. 56, No. 2, 1958, p. 174-179.

that R-S strength measured in terms of subject's ability to recall the functional S-R stage stimulus is maximal, and significantly greater than subject's ability to reproduce the nominal S-R stage stimulus, was obtained by Houston.¹⁶ Although the relevance of the data is stated to be primarily that of indicating previous inappropriateness of tests for R-S strength, the data simultaneously serve to highly substantiate the stimulus selection view from measurements of R-S association. An experiment by Young, Farrow, Seitz and Hays¹⁷ has added support to Houston's findings. These authors demonstrated that whether the influence of stimulus selection is measured through the use of forward or backward associations the same relative results are obtained, namely, an interaction between stimulus meaningfulness and stimulus-component recalled.

The effect of stimulus meaningfulness as a parameter of stimulus selection in paired-associates has been investigated by Cohen and Musgrave.¹⁸ It was demonstrated that subjects' selection will be of the most

16 Houston, Op. Cit.

17 Robert K. Young, et. al. "Backward Recall with Compound Stimuli", Journal of Experimental Psychology, Vol. 72, No. 2, 1966, p. 241-243.

18 Cohen and Musgrave, Op. Cit.

meaningful element. Where the stimulus term was composed of two verbal components, cue selection was found to be a function of meaningfulness of the component and additionally of its position in the compound if the component was of low meaningfulness. Associations between responses and components of stimuli differed in strength despite equal opportunities for practice. The results agree with those of cue selection experiments which combined verbal units and colored background as stimuli. In one example, Young, Teeters and Zelazny¹⁹ had subjects learn two paired-associate lists consisting of compound stimuli using color-nonsense syllable combinations. Meaningfulness of the word was manipulated to determine the influence of this variable upon the amount of transfer in subsequent learning. When the level of meaningfulness of nonsense syllables was low, negative transfer occurred indicating that stimulus selection was a function of meaningfulness of the verbal units employed.

Few research studies have been carried out which are directly related to the present thesis. A general summary of the present status of previous findings may be compiled

¹⁹ Robert K. Young, Tony D. Teeters and Charles Zelazny, "Transfer as a Function of Stimulus Selection", Psychonomic Science, Vol. 6, No. 4, 1966, p. 163-164.

as follows: paired-associate learning is usually facilitated by surrounding primary stimuli with item-specific color; a stimulus selection occurs in which subjects select but one cue from a multiple-element compound as functional stimulus for response elicitation; stimulus selection is that of the most meaningful stimulus component.

2. Associative Summation Theory versus
Differentiation Theory.

Of more recent concern in studies on the effects of contextual cues in paired-associates is whether facilitation occurs because the contextual cues aid in differentiating the verbal primary stimuli or whether facilitation is due to additional associative effects of the cues. Distinctive camps appear to have evolved between the associative summation theory of Birnbaum²⁰ and Greeno²¹ and the differentiation theory suggested by Saltz²² and by

20 Irene M. Birnbaum, "Context Stimuli in Verbal Learning and the Persistence of Associative Factors", Journal of Experimental Psychology, Vol. 71, No. 4, 1966, p. 483-487.

21 James G. Greeno, "Associative Effects versus Differentiation: Comment on Saltz and Wickey's Reply to Birnbaum", Psychological Reports, Vol. 22, No. 2, 1968, p. 347-350.

22 Eli Saltz, "Compound Stimuli in Verbal Learning: Cognitive and Sensory Differentiation versus Stimulus Selection", Journal of Experimental Psychology, Vol. 66, No. 1, 1963, p. 1-5.

Saltz and Wickey.²³ In a series of "criticisms" and "replies" between these authors, a reply to Greeno, in 1968 by Saltz and Ager²⁴ provides the following distinctions between the two theories. According to the summation theory, each element of the compound cue becomes associated to the response. The elicitation of a correct reponse is a function of the summed associative strengths. On the other hand, the differentiation theory suggests that only one of the stimuli in the compound becomes the functional cue and other cues act to increase the distinctiveness between the stimulus compounds.

Hill and Wickens²⁵ tested whether learning is facilitated when there are two cues available rather than one. The authors suggest that the concept of summation could not account for the enhanced learning which resulted from receiving the compound. Their interpretation reads that the superior performance found for the dual-stimulus groups could be

23 Eli Saltz and John Wickey, "Further Evidence for Differentiation Effects of Context Stimuli: A Reply to Birnbaum", Psychological Reports, Vol. 20, No. 3, 1967, p. 835-838.

24 Eli Saltz and Joel W. Ager, "Role of Context Cues in Learning: Reply to Greeno", Psychological Reports, Vol. 22, No. 2, 1968, p. 351-354.

25 Frances A. Hill and Delos D. Wickens, "The Effect of Stimulus Compounding in Paired-Associate Learning", Journal of Verbal Learning and Verbal Behavior, Vol. 1, No. 2, 1962, p. 144-151.

accounted for in that the subject selects one or the other stimulus dimension for a particular response and thus produces his own functional stimulus. Increasing the number of cues provides more opportunities for cue selection and increased differentiation. Brown, Battig, and Pearlstein²⁶ also found positive effects with an increase in number of cues. They compared performance using constant three-letter stimulus terms against conditions beginning with a single-letter stimulus and successively adding second and third letters. Subjects demonstrated substantial learning of additional stimulus elements even though the conditions were designed expressly to maximize selection of a single-element.

A third experiment is most noteworthy and of particular pertinence to the present study. Swede and McNulty²⁷ examined the effects of adding, subtracting, or changing contextual cues on the learning and retention of paired-associates. For a group who had learned the pairs

26 Sam C. Brown, William F. Battig and Richard Pearlstein, "Effect of Successive Addition of Stimulus Elements on Paired-Associate Learning", Journal of Experimental Psychology, Vol. 70, No. 1, 1965, p. 87-93.

27 George Swede and John A. McNulty, "The Influence of Contextual Cues upon the Learning and Retention of Paired-Associates", Canadian Journal of Psychology, Vol. 21, No. 5, 1967, p. 394-408.

under a color-plus-shape context (e.g. yellow triangle), there was a decrement in recall only when both contextual cues were removed in a test of retention. This finding, the authors proclaim, does not unequivocally support the stimulus selection hypothesis. When two contextual cues (shape and color) are present in learning, removing one of them should cause a decrement in retention scores, and removing both a greater decrement. Only the removal of both contextual cues in retention had a detrimental effect upon recall. Swede and McNulty concluded that with their particular content material learning to associate a response to one of the contextual cues inadvertently forced the subject to associate his response to the other cue as well. What occurred? Was the phenomenon a case of associative summation or of differentiation? The author will not attempt to answer the above dilemma. However, in the light of Brown, Battig and Pearlstein's²⁸ findings the differentiation view appears the more plausible. If, as these authors have shown, additional successive elements are learned (which also is contrary to the stimulus selection hypothesis) then it is possible that S's in the Swede and McNulty²⁹ study learned to associate to one cue and on successive trials learned to associate to the other

28 Brown, Battig and Pearlstein, Op. Cit.

29 Swede and McNulty, Op. Cit.

cue as well. In other words, the cues did not add but were both learned successively. During recall either cue could be capable of response elicitation. This brings about the question asked in the present thesis: May or may there not be cases in which two contextual cues serve as but one functional stimulus or cases in which two cues may independently serve as functional stimuli?

3. Sources of the Hypotheses.

As a prerequisite to a clear understanding of the hypotheses to be formulated, the author deems it necessary at this point to indicate four studies which were influential in the selection of materials. The materials to be used in the present study have been deliberately chosen to provide consonant and dissonant components within the stimulus term. The experimenter's selection consists of congruent and incongruent contextual cues surrounding nonsense figures as stimulus terms and nonsense syllables as response terms.

In addition to the study by Swede and McNulty³⁰ previously reviewed, three other works were influential in the selection of materials, namely, those of Sundland and

30 Swede and McNulty, Op. Cit.

Wickens,³¹ Saufley and Underwood³² and Stroop.³³ Sundland and Wickens have suggested that the effectiveness of a context cue will be a function of an interaction between the discriminability among the individual primary cues and the discriminability among the contextual cues. They have shown that context cues will have greater or lesser cue value as a function of the nature of the primary cue, and, they suggest it to be plausible that the same relationship would hold if context discriminability were varied and primary cues held constant. In view of this assumption, an approximately medial and constant association level of nonsense figures has been selected as primary stimuli in the present study. Saufley and Underwood have been influential in E's choice of Stroop's concept for construction of congruent and incongruent contextual cues. The critical units in their experiment on cue-selection interference were names of colors. Inappropriate ink colors (i.e., the word red in blue ink) were expected to produce

31 Sundland and Wickens, Op. Cit.

32 William H. Saufley and Benton J. Underwood, "Cue Selection Interference in Paired-Associate Learning", Journal of Verbal Learning and Verbal Behavior, Vol. 3, No. 6, 1964, p. 474-479.

33 J. R. Stroop, "Studies of Interference in Serial Verbal Reactions", Journal of Experimental Psychology, Vol. 18, No. 6, 1935, p. 643-662.

interference. Subjects were required to associate ink colors to response terms. Interference occurred when the word and ink color were consistent from trial to trial and when these were response terms. It was suggested that interference was produced because the dominant habit of responding to the words resulted in an association being established initially between the words and numbers.

Although the material per se used in the present experiment is different than that of Saufley and Underwood, Stroop's concept is similarly used.

4. Formulation of the Hypotheses.

In view of the preceding observations, the purpose of the present experiment is two-fold: 1) to study whether congruent cues may be functionally equivalent; 2) to investigate within another context the contention of Swede and McNulty, namely, that subjects may be inadvertently forced to associate a response to two cues. Compatible to the purpose, the present experiment is thus designed to examine the effects of congruent and incongruent contextual cues on the learning and retention of paired-associates.

The hypotheses to be examined are stated in the general form:

1. Congruent contextual cues being of a consonant nature, subjects should, during learning (L), associate the two components as functional stimuli for response elicitation. The hypothesis of an equivalence of functional stimuli is formulated and may be verified in a test of retention (T). Experimental Group A₁.
2. Incongruent contextual cues being of a dissonant nature, subjects should, during learning (L), select one or the other cue as functional stimulus or resort to the selection of the primary stimulus depending on the relative strength of the contextual dissonance to the discriminability of the primary stimulus. It is predicted that dominant habit of responding (cue selection) will be of color words. Selection may be verified in a test of retention (T). Experimental Group B₁.
3. A control group (C) with primary stimuli alone (in L) is forced to associate responses to these stimuli. Retention should therefore be better under this no context (in L) -- no context (in T) condition than in any subgroup derived from experimental groups in which a context (in L) -- no context (in T) is tested.

The level of meaningfulness of materials used as congruent and incongruent contextual cues may be varied by means of less familiar but similar cues. Two such conditions were arbitrarily composed and added to the present experiment in order to test for possible interactive effects of this variable on the predicted phenomena stated in hypotheses one and two. (These two groups shall hereafter

be referred to as Experimental Groups A_2 and B_2).

4. Although rate of learning (L) and amount of retention (T) may differ concomitantly between groups (A_1 and B_1) with groups (A_2 and B_2) due to the difference in level of meaningfulness, the above predictions of equivalence (No. 1) and of cue selection (No. 2) should still apply. The predictions may be verified in tests of retention (T). Experimental Groups A_2 and B_2 .

In summary, the present experiment is directed towards the study of the effects of congruent and incongruent compounds on paired-associates. With congruent contextual cues it is postulated that an equivalence of stimuli may occur so that either cue may serve as functional stimulus. With incongruent contextual cues it is postulated that only one cue will serve as functional stimulus and stimulus selection will depend on the dominant habit of responding. Both types of cues are postulated to have facilitating effects on recall. Finally, the phenomena of equivalence and of cue selection for congruent and incongruent cues are predicted to be applicable independently of the familiarity level of the compounds.

Complementary information on the specific points investigated will be presented in the form of introductory remarks to the presentation of results.

CHAPTER II

EXPERIMENTAL DESIGN

This chapter presents the sample and design, the materials, and the procedures used in testing the proposed hypotheses. Finally, the organization of data is discussed.

1. The Sample and Design.

One hundred female student nurses at the University of Ottawa volunteered as subjects. The mean age of the sample was 24.7 with a standard deviation of 4.4. Subjects formed part of the total 180 students in an introductory psychology course.

Five groups of subjects learned a list of five paired-associates with nonsense figures as stimuli and nonsense syllables as responses. Two groups of twenty subjects each learned the list with congruent contextual cues (color words in their respective ink colors) surrounding the nonsense figures. Each of these groups learned the list with a different set of congruent cues. Two groups of twenty subjects learned the list with incongruent contextual cues (color words in inappropriate ink colors). These groups learned with a different set of incongruent cues. A control group of twenty subjects learned the paired-associates without contextual cues.

In learning (L), a schedule sheet of twenty blocks of five conditions each was constructed with each condition occurring but once within each block. The order of conditions within each block was determined by randomization. The one hundred subjects were assigned to the schedule in the order of their appearance for the experiment. In this manner any "lost subject" was simply replaced by the next volunteer until a total of one hundred subjects were tested.

Retention was measured twenty-four hours after original learning. Five subjects in each of the four experimental groups had retention measured under the same context conditions as in original learning. The remaining fifteen subjects of each experimental group, also subdivided into groups of five, were tested under conditions of diminished cue elements with primary stimulus present. The twenty subjects of the control group were tested with primary stimulus alone as in original learning.

In retention (T), five blocks of four conditions were randomized for experimental groups A_1 , A_2 , B_1 , and B_2 respectively, thus permitting predetermined assignment to one of the four possible conditions (in T) per group. This was not required (in T) for the control group tested under the original no cue condition. Tables I and II summarize the design by presenting the stimulus-term conditions in both learning and retention.

TABLE I.- Stimulus-Term Conditions in Learning.

	<u>B₁</u>	<u>B₂</u>	<u>N</u>
A ₁	5NF + HCW + CC	5NF + HCW + ICC	40
A ₂	5NF + LCW + CC	5NF + LCW + ICC	40
CONTROL 5 NF			20

NF = Nonsense figure
 HCW = High Meaningfulness color word
 LCW = Low Meaningfulness color word
 CC = Congruent color
 ICC = Incongruent color

TABLE II.- Stimulus-Term Conditions in Retention.

		C ₁	C ₂	C ₃	C ₄	N
A ₁	B ₁	5NF+HCW+CC	5NF+HCW	5NF+CC	5NF	20
	B ₂	5NF+HCW+ICC	5NF+HCW	5NF+ICC	5NF	20
A ₂	B ₁	5NF+LCW+CC	5NF+LCW	5NF+CC	5NF	20
	B ₂	5NF+LCW+ICC	5NF+LCW	5NF+ICC	5NF	20
CONTROL 5NF						20

NF = Nonsense figure
 HCW = High meaningfulness color word
 LCW = Low meaningfulness color word
 CC = Congruent color
 ICC = Incongruent color

2. The materials.

Primary stimuli within the stimulus terms consisted of five nonsense figures randomly chosen from the table of shapes constructed by Vanderplas and Garvin.¹ As an inverse relation exists between the complexity of random shapes and the number, content and heterogeneity of their associative responses,² restrictions were imposed by the experimenter to ensure the use of contextual cues as functional stimuli by at least some of the subjects. These restrictions were that the figures be of an eight-point complexity level with association values at twenty-eight per cent. The five nonsense figures were then randomly chosen from the potential items and simultaneously distributed as stimulus terms 1 to 5. (See Appendix 2).

For stimulus terms with contextual cue conditions, each nonsense figure was surrounded by a square with outer dimensions of 1" x 1" and a frame width of 1/5". The base of all frames was constructed parallel to the baseline of the nonsense figures in order to preserve and conform to the criteria on which the associative values of the figures

1 James M. Vanderplas and Everett A. Garvin, "The Association Value of Random Shapes", Journal of Experimental Psychology, Vol. 57, No. 3, 1959, p. 147-154.

2 Vanderplas and Garvin, Op. Cit.

were found. All contextual cues were printed and/or colored within the frame area. Where printed color-words were required such cues were reproduced four times, one per side of frame. When conditions of color alone were required, such as in retention test, the complete area of the frame was colored appropriately. Color and print were clearly visible and readable in all conditions. A lettering-guide of 1/8" was used for construction of color words. Conditions which required color word only were printed in black in conformity to the standard. Thus the color black was used in tests of retention but never as a contextual cue in learning.

Contextual cues, inscribed within the frames which contoured the nonsense figures, were constructed of color and color word combinations. A particular problem arises when one uses colors for which no empirical associative values have yet been established. The color words were therefore arbitrarily grouped into two lists by E on the subjective judgment that List I may be more familiar than List II. This was done to test for interactive effects (if any) of meaningfulness upon the phenomena being studied. Alternatively, one would have been justified in using an unbiased selection from the ten available colors into a single list of five color words, than randomly combining these with the remaining colors. Such a technique is current

in studies using color as cues. The experimenter can assume meaningfulness of material to be nondifferentially distributed. It cannot, however, be denied that the level of meaningfulness of the material used does have an effect on the dependent variable. This alternative, according to the author, simply replaces one weakness by a more severe one, namely, that of avoiding the issue. Consequently, in the present study two lists of color words were preferred with List I randomly selected from the eight standard basic colors and List II randomly selected from the remaining colors which could be easily identified and discriminated.

List I consisted of the five color words: orange, brown, red, blue, and green; List II of the five color words: gray, violet, yellow, pink, and purple. For conditions requiring congruent contextual cues, groups A_1 and A_2 , List I and List II were printed respectively in their appropriate colors. For one condition requiring incongruent contextual cues, group B_1 , the color words of List I were printed in the inappropriate colors indicated by List II. These combinations were obtained randomly (i.e., orange was printed in pink). For the other condition requiring incongruent contextual cues, group B_2 , the opposite incongruencies were used (i.e., pink was printed in orange). Thus were obtained two congruent and two incongruent series of cues. They were

then randomly coupled with nonsense figures for one series and the order obtained was now kept constant for each series of the four experimental groups.

Five CVC nonsense syllables from Archer's³ tables were used as response terms. Restrictions were limited to a choice of ten per cent meaningful syllables with no two first letters same in different CVC's. A random selection of these potential items was performed and distributed as response terms 1 to 5. (See Appendix 2). Nonsense syllables with the above restrictions were preferred to the now more common use of single digits as response terms in order to increase the difficulty and duration of the paired-associate task. This would in turn increase the number of exposures to the contextual cues in the stimulus terms.

The nonsense figures were transposed and xeroxed directly to a white background circle of 2" diameter. Nonsense syllables were in like manner produced and contained in circles as response terms. It was then possible to obtain the required number of exact duplicates from xerox. The stimulus and response items were then positioned on 3 1/2" x 6" plastic cards by means of double-sided adhesive tape. Contextual cues were subsequently imposed. A clear

3 E. James Archer, "A Re-evaluation of the Meaningfulness of All Possible CVC Trigrams", Psychological Monograph, Vol. 74, No. 10, (Whole No. 497), 1960, p. 1-23.

adhesive film covering served to preserve the material intact throughout the entire experiment. Twenty-five cards were so constructed for (L), an additional twenty were required for the variety of (T) conditions and one asterisk marked card as indicator, thereby constituting a total of forty-six cards. The presentation of material was accomplished by means of a Hunter Model 340 Cardmaster.

3. The Procedure.

Each subject was initially tested with the American Optical Company Pseudoisochromatic Plates and asked to name the numbers. Color-deficient subjects were excused. To ensure uniformity of color word recognitions, subjects were given a card with the colors used for his group and were asked to name them. Any required corrections in naming were pointed out to subjects.

Each subject was informed on the context of the materials particular to his condition and on the task demanded. Experimental Groups B_1 and B_2 were informed of the distinction between the word and the color in which it was printed. Subjects were simply told that in learning the paired-associates they were to make use of the stimulus as associative means without reference to part(s) or whole by E. All subjects were informed that when a stimulus item appeared they were to spell aloud the response item paired

before the latter was shown. (Anticipation Method). Subjects were informed not to attempt to learn according to serial order, due to E's random presentation of cards. (See Appendix I).

Two familiarization trials to acquaint subjects with the operation of the apparatus and with the task expected were accomplished by means of S-R marked cards.

The experiment proper then began using the "adjusted learning technique" as suggested by Madden, Adam and Spence.⁴ In the usual method of presentation some responses are correctly anticipated more often than others. In the adjusted-method, removal of correctly anticipated responses from the learning list yields essentially the same degree of learning by every subject on each pair. "Overlearning" of specific pairs is thereby avoided. When using the adjusted-method a distinction must be made between trials and subtrials. On a trial the five pairs are presented. Correctly anticipated item(s) are removed and the remainder are then presented as a subtrial. Subtrials are continued until all S-R pairs have been anticipated correctly once. The next trial begins with all five

⁴ Marian S. Madden, Jack A. Adams and Shirley A. Spence, "Memory-Drum versus Adjusted Learning Techniques in the Study of Associative Interference in Learning by Paired-Associates", American Journal of Psychology, Vol. 63, No. 2, 1950, p. 186-195.

pairs presented. Learning continues in this manner until subject can anticipate correctly all items in one presentation. The order of pairs is always random.

Pairs were presented at the rate of two seconds per stimulus-item with a two-second per stimulus-response exposure. The inter-pair interval was three seconds. Between every trial and/or sub-trial a thirty-second interval permitted the experimenter to randomly re-order the cards for the next presentation.

Subjects were told to come back twenty-four hours later for another experiment, the nature of which was not revealed. During the second session, retention was measured and the same procedures as above were followed until subjects reached the relearning criterion of one perfect recitation.

4. The Dependent Variables and Analytical Procedures.

Three measurements of learning were acquired: trials to the criterion of one perfect recitation, number correct per trial and number of errors per trial. With the adjusted-learning technique used, number correct and number of errors per trial must be distinguished. They are not, as in the usual method of scoring paired-associate learning, complements of one another. The number correct per trial is the number correct on the first presentation, whereas,

the number of errors per trial equals the number of errors on any particular trial plus all sub-trials within that series. The maximum a subject could have correct on any one trial is five, but there is theoretically no limit to the number subject could have wrong per trial.

The mean trials to criterion for each of the five context conditions were calculated. The rank order of the five conditions was noted with rank number one attributed to the group having the lowest mean trials to criterion, rank number two to the group having the second lowest, etc. The fixed effects analysis of variance was followed by a Newman-Keuls test for differences between all possible pairs of means. The effects of congruency factor and meaningfulness factor were investigated by means of a 2 x 2 factorial analysis on the experimental groups.

The average number correct per trial and average number of errors per trial served as second and third learning measurements. An arcsin transformation was performed on number correct and a reciprocal square root transformation on number of errors. Fixed effects analyses were computed for both measures. The Newman-Keuls range test was used to test for differences of means. The experimental groups were then analyzed from a 2 x 2 x 7 factorial with repeated measures on the last factor.

Four retention measures were acquired: data-recall, mean trials to reach relearning criterion, number correct per trial and number of errors per trial. Data-recall is the number of responses given correctly by subject on the first presentation of the stimulus terms. Data-recall is the only true measurement of retention since the other measurements may be considered as measurements of relearning.

Mean recall scores were calculated and ranks were again noted. The fixed effects analysis of variance, 5×4 design, was followed by the Newman-Keuls. A $2 \times 2 \times 4$ factorial analysis was computed on experimental groups. Similar analyses were performed for number of trials to reach relearning criterion.

The transformed scores for mean number correct per trial in relearning and transformed scores of mean number of errors per trial in relearning were subjected to a $5 \times 4 \times 3$ factorial analysis. Following the Newman-Keuls range test, the experimental groups on both measurements were analyzed for factor effects by a $2 \times 2 \times 4 \times 3$ factorial with repeated measures on the last factor.

CHAPTER III

PRESENTATION OF RESULTS

The presentation of results is divided into two sections: measurements of learning and measurements of relearning.

1. Results of Learning Data.

The stimulus selection hypothesis predicts that learning is enhanced as a function of the number of cues available. Theoretically, three cues should be better than two and two better than one assuming that each component of the nominal stimulus has an equal probability of being chosen as functional stimulus. The critical experimental problem is that of identifying the nature and relative strengths of the habits elicited by various stimulus compounds which account for the selection of the functional stimulus. If a purely additive model of stimulus selection applied, it would be predicted that incongruent cue conditions with two item specific contextual cues should demonstrate better learning than congruent cue conditions since the latter may be assumed to have only one contextual cue because of stimulus equivalence. Alternatively, if subjective strengths of responding apply as an integral part of the stimulus selection hypothesis then incongruent

contextual cues should hinder learning because of interference. Many psychological processes may be invoked to explain interference reduction, e.g. associative summation, differentiation, decreased complexity of information processing, etc. However, the main preoccupations of this study are on the global effects of learning and the specific effects on retention of contextual cue parameters. For these reasons no hypotheses have been made about learning data results. The global effects of congruent and incongruent contextual cues on learning may be noted in the following measurements: trials to criterion, number correct per trial and number of errors per trial.

Trials to Criterion in Learning. The mean number of trials required to reach the learning criterion of one perfect recitation were 5.4, 5.9, 6.1, 6.5, and 9.2 respectively for congruent groups A_1 and A_2 , incongruent groups B_1 and B_2 and the no context control group C. The results for trials to criterion are shown in Figure I. Learning under congruent contextual cue conditions required the fewest number of trials; learning under incongruent contextual cue conditions were next with slightly more trials while learning under no context required the most number of trials. The fixed effects analysis of variance, summarized in Table III, shows a significant effect due to treatment ($F = 21.11$; 4 and 95 df: $P < .01$). The Newman-Keuls

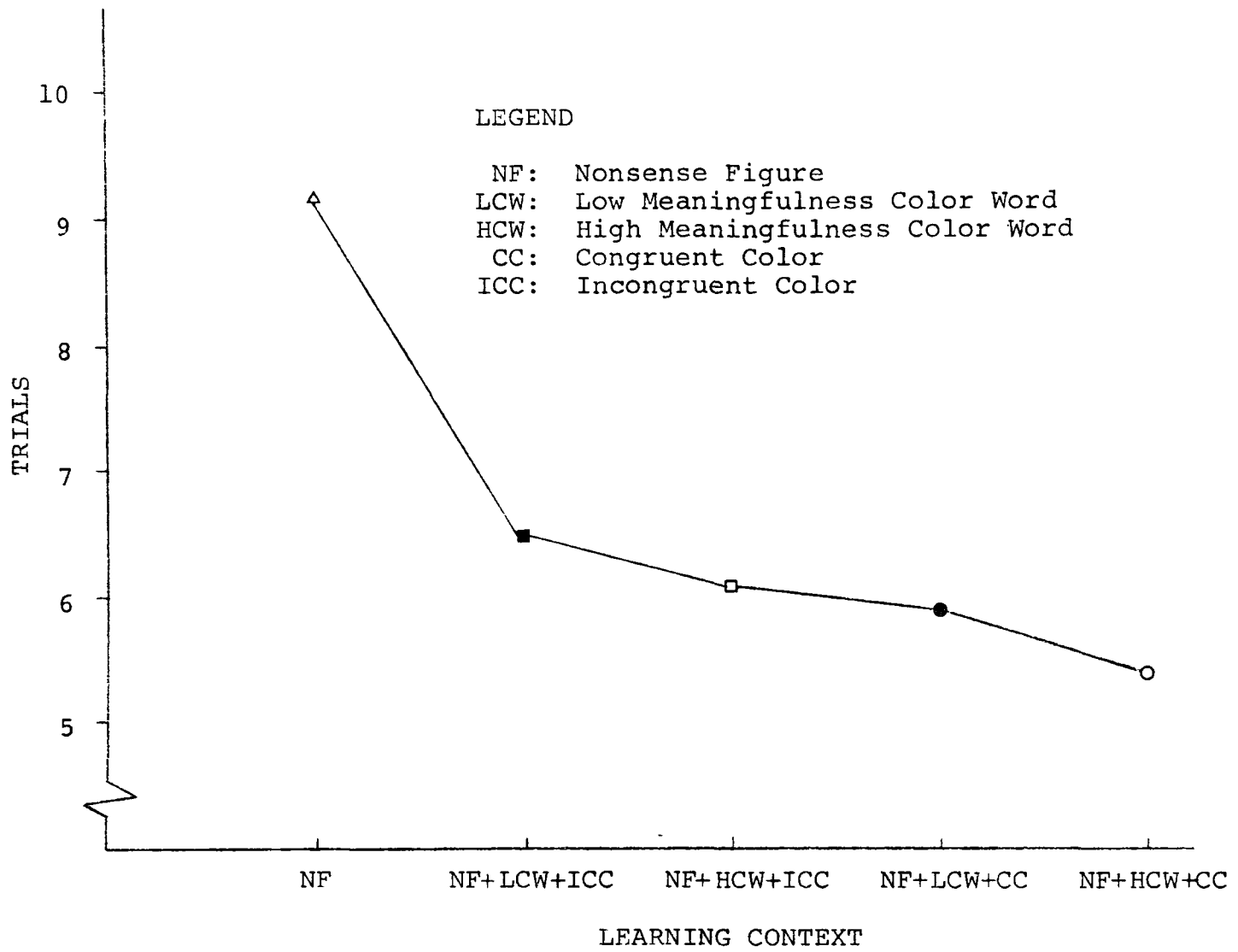


Fig. 1. Mean trials to criterion in learning.

TABLE III.- Summary of the Analysis of Variance for
Trials to Criterion in Learning.

Source	SS	df	MS	F
Between Conditions	177.56	4	44.39	21.11 ***
Within Conditions	199.75	95	2.10	
TOTAL	377.31	99		

*** Significant at the .01 level.

revealed that the no context condition differed at the .01 level from the four experimental conditions. Congruent group A_1 did not differ from congruent group A_2 nor did incongruent group B_1 differ from incongruent group B_2 suggesting that probably the arbitrarily chosen levels of meaningfulness had no significant effect. However, congruent groups differed significantly from incongruent groups suggesting that the congruency factor may have had a significant effect. The observed concomitant variation as predicted in the prelude of hypothesis number four, for groups A_1 and B_1 with A_2 and B_2 suggested that congruency and meaningfulness did not interact. A 2 x 2 factorial analysis of the experimental groups, Table IV, revealed the congruency factor to be significant beyond the .05 level ($F = 4.84$; 1 and 76 df: $P < .05$). Meaningfulness factor was not significant as well as interaction. According to the stimulus selection hypothesis the opportunity to select enhances learning if S can choose a stimulus which is more compatible with the response or which reduces stimulus generalization. The rank order of learning conditions in the present study indicates by trials to criterion that such a facilitation occurred for congruent cue conditions and to a lesser degree for incongruent cue conditions, irrespective of the level of meaningfulness of materials.

TABLE IV.- Summary of the Analysis of Variance of
Experimental Groups for Trials to Criterion
in Learning.

Source	SS	df	MS	F
A (Meaningfulness)	4.5125	1	4.5125	2.79
B (Congruency)	7.8125	1	7.8125	4.85 *
AB	0.1125	1	0.1125	0.07
Error	122.5500	76	1.6125	
TOTAL	134.9875	79		

* Significant at the .05 level.

Number Correct per Trial in Learning. The average number of items correct per trial are shown in Figure 2. The scores for only the first seven trials are presented because at this point most of the S's in each group had learned the complete list. The rank order shows that congruent cue conditions resulted in the greatest number correct per trial, incongruent cue conditions had fewer correct while the no context control had the least number correct.

An arcsin transformation to correct for asymptotic effects was performed on number of correct items per trial.^{1,2} The fixed effects analysis of variance on the transformed scores, represented in Table V, revealed that the variable of learning conditions was significant. Trials had a significant effect but this was not surprising as learning was certain to improve over trials. The interaction of trials and conditions is also seen as being significant. The Newman-Keuls was used to test on the difference between all possible pairs of means. The control again differed beyond the .01 level from each of the four experimental conditions. Congruent cue conditions did not however differ significantly from incongruent cue conditons on mean number correct per

1 J. P. Guilford, Psychometric Methods, New York, McGraw-Hill, 1954, p. 163-165.

2 Roger E. Kirk, Experimental Design: Procedures for the Behavioral Sciences, Belmont, California, Brooks/Cole Publishing Company, 1968, p. 63-67.

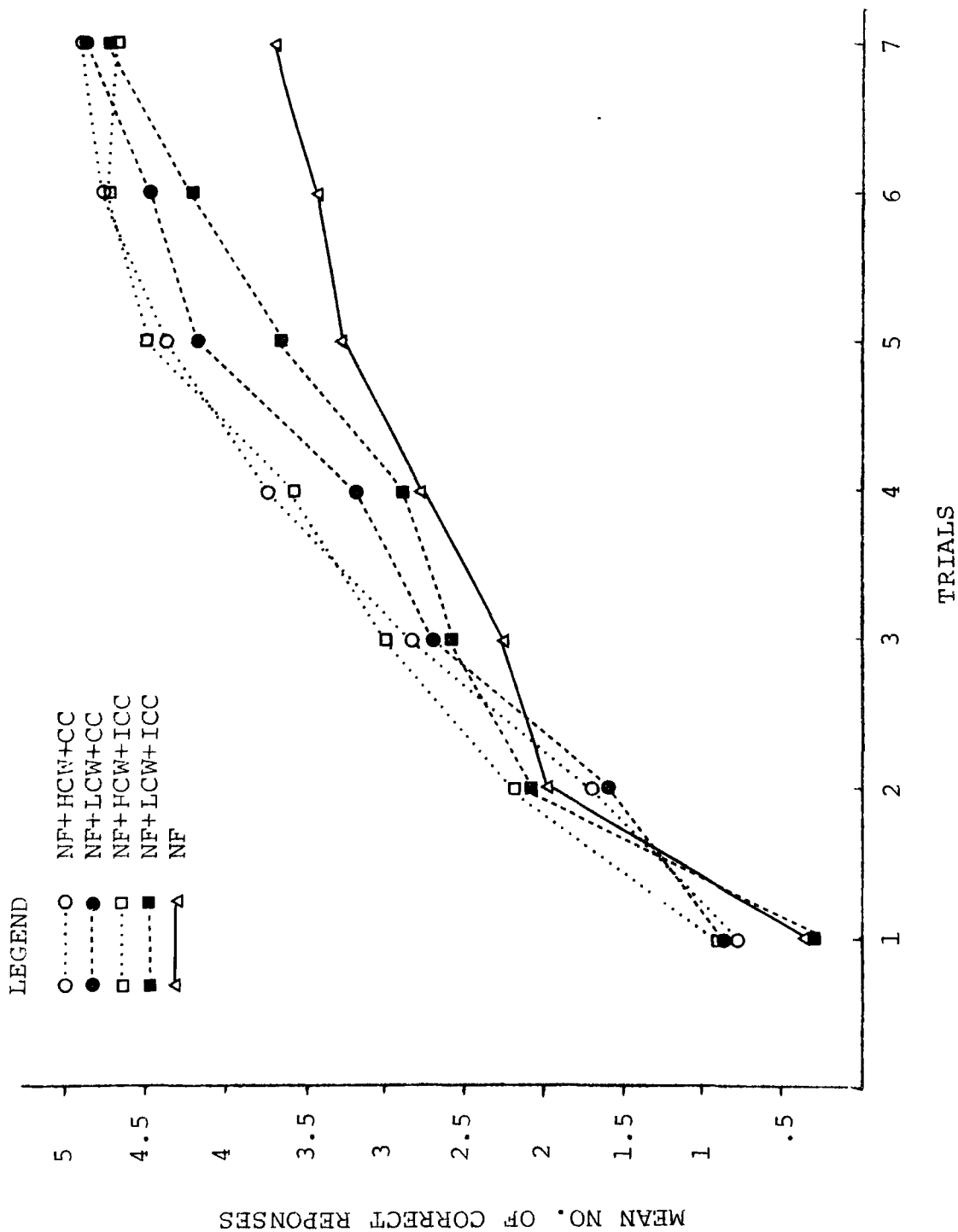


Fig. 2. Mean number of correct responses per trial in learning.

TABLE V.- Summary of the Analysis of Variance for
Number Correct per Trial in Learning.

Source	SS	df	MS	F
<u>Between Subjects</u>	<u>72353.39</u>	<u>99</u>		
Learning Conditions	19080.53	4	4770.13	8.51 ***
Error (b)	53272.86	95	260.77	
<u>Within Subjects</u>	<u>422558.57</u>	<u>600</u>		
Trials	312969.05	6	52161.51	300.19 ***
Trials X Conditions	10543.48	24	439.31	2.53 ***
Error (w)	99046.04	570	173.76	
TOTAL	494911.96	699		

*** Significant at the .01 level.

trial. Meaningfulness factor also appeared not to be significant. Consequently, a 2 x 2 x 7 factorial analysis, with repeated measures on the last factor, was performed on the experimental groups (Table VI). Neither of the main effects of congruency factor nor meaningfulness factor were significant. The only significant F ratio, besides the effect of increased learning due to trials as mentioned above, was that of interaction between congruency X trials ($F = 2.37$; 6 and 456 df: $P < .05$).

Number of Errors per Trial in Learning. Figure 3 shows the average number of errors per trial for the first seven trials. The rank order of conditions is compatible with that of number correct per trial. Congruent cue conditions resulted in less errors per trial, incongruent cue conditions had more errors while the control had the greatest number of errors.

A reciprocal square root transformation to correct for marked positive skewness was performed on number of errors per trial.³ The fixed effects analysis of variance on the transformed scores (Table VII) revealed that learning conditions, trials and interaction were significant. The Newman-Keuls revealed that the control differed beyond the

³ B. J. Winer, Statistical Principles in Experimental Design, New York, McGraw-Hill, 1962, p. 218-222.

TABLE VI.- Summary of the Analysis of Variance of
Experimental Groups for Number Correct per
Trial in Learning

Source	SS	df	MS	F
<u>Between Subjects</u>	<u>46228.42</u>	<u>79</u>		
A (Meaningfulness)	2010.22	1	2010.22	3.59
B (Congruency)	1305.41	1	1305.41	2.33
AB	334.79	1	334.79	-
Subjects within groups	42578.00	76	560.24	
<u>Within Subjects</u>	<u>363193.14</u>	<u>480</u>		
C (Trials)	278498.37	6	46416.39	264.82 ***
AC	1475.44	6	245.91	1.40
BC	2489.35	6	414.89	2.37 *
ABC	804.83	6	134.14	-
CX Subjects within groups	79925.15	456	175.27	
TOTAL	409421.55	559		

* Significant at the .05 level.

*** Significant at the .01 level.

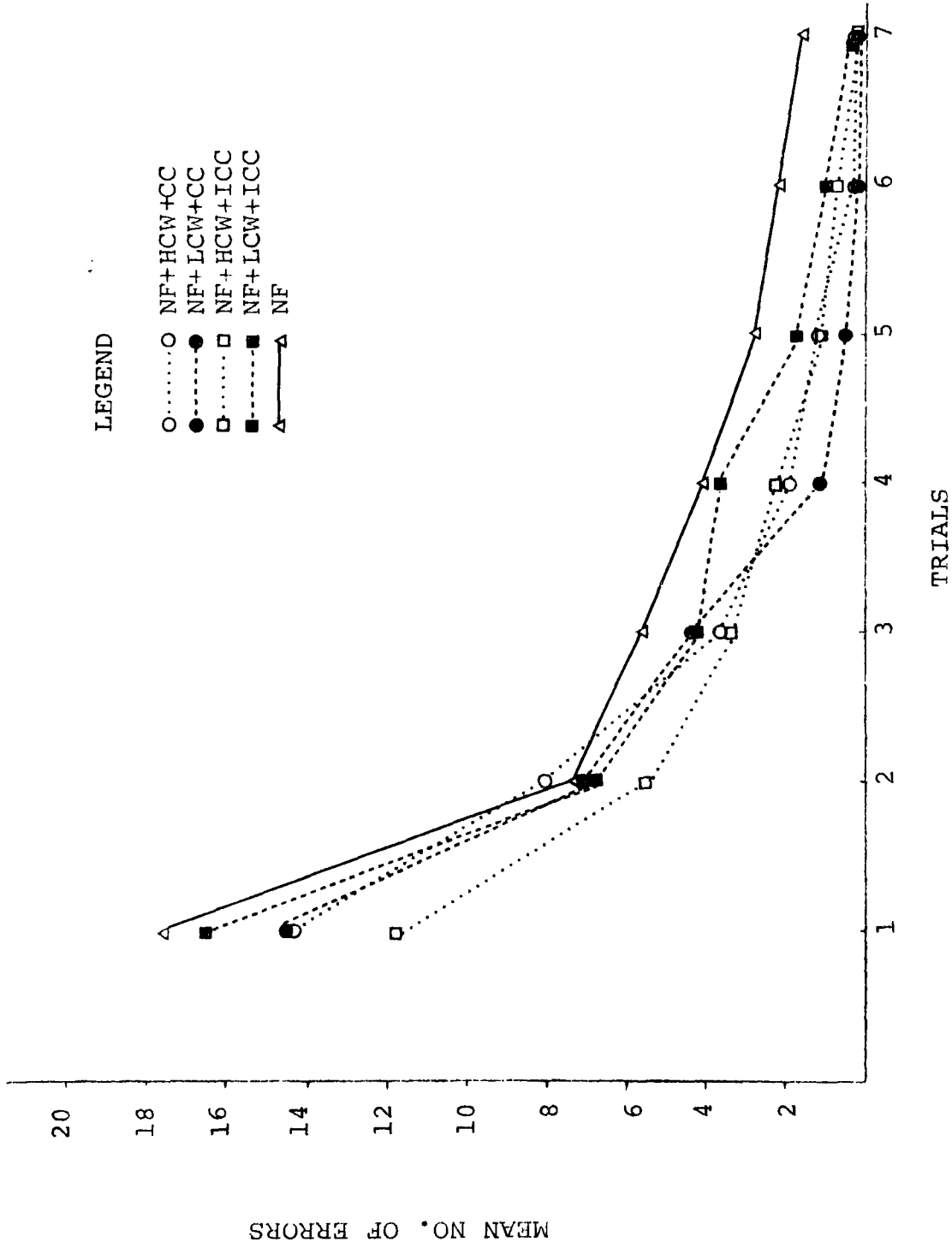


Fig. 3. Mean number of errors per trial in learning.

TABLE VII.- Summary of the Analysis of Variance for
Number of Errors per Trial in Learning.

Source	SS	df	MS	F
<u>Between Subjects</u>	<u>8.62</u>	<u>99</u>		
Conditions	2.08	4	.52	7.53 ***
Error (b)	6.54	95	.069	
<u>Within Subjects</u>	<u>40.90</u>	<u>600</u>		
Trials	31.62	6	5.27	376.43 ***
Trials X Conditions	1.37	24	.057	4.07 ***
Error (w)	7.91	570	.014	
TOTAL	49.52	699		

*** Significant at the .01 level.

.05 level from each of the experimental groups. Congruent and incongruent cue conditions did not differ. Meaningfulness appeared again not to be significant. The analysis of the experimental groups by means of a 2 x 2 x 7 factorial (Table VIII) showed similar results as obtained for number correct per trial with the exception that congruency X trials was not significant beyond the .01 level instead of the .05 level. ($F = 3.63$, 6 and 456 df: $P < .01$). Both of the measures of correct per trial and errors per trial indicated that stimulus selection operated differentially at different stages. The raw data simultaneously indicated that cue selection during learning for the unfamiliar and incongruent conditions occurred only within the second or third trial and was difficult to maintain. Cue selection as inferred from number correct per trial and number of errors per trial for the remaining experimental groups occurred on the first trial.

2. Results of Relearning Data.

The same distinction made for learning data between number correct per trial and number of errors per trial applies to retention and relearning data; they are independent measurements and not complementary. Data recall is the only true measure of retention. Trials to criterion, number correct per trial and number of errors per trial may be considered as measures of relearning.

TABLE VIII.- Summary of the Analysis of Variance of Experimental Groups for Number of Errors per Trial in Learning.

Source	SS	df	MS	F
<u>Between Subjects</u>	<u>6.835</u>	<u>79</u>		
A (Meaningfulness)	.262	1	.262	3.09
B (Congruency)	.0995	1	.0995	-
AB	.0194	1	.0194	-
Subjects within groups	6.4541	76	.0849	
<u>Within Subjects</u>	<u>36.5753</u>	<u>480</u>		
C (Trials)	29.3549	6	4.8925	332.82 ***
AC	.1246	6	.0208	1.41
BC	.3203	6	.0534	3.63 ***
ABC	.0725	6	.0121	-
CX Subjects within groups	6.703	456	.0147	
TOTAL	42.6588	559		

*** Significant at the .01 level.

In addition to the previously noted prediction of enhanced learning as a function of cues available during learning, the stimulus selection hypothesis predicts that removal of contextual cues in retention is detrimental to recall and the detriment should be proportional to the number of cues removed. The best condition(s) for retention should therefore be the control no context (in L) - no context (in T) and/or the conditions in which context (in L) - similar context (in T) are tested. The poorest condition should be context (in L) - no context (in T) while conditions with context (in L) and removal of one cue in retention should result in recall detriment at an intermediate level.

For relearning measurements (trials to criterion, number correct per trial and number of errors per trial) the following predictions should apply. The context (in L) - no context (in T) and/or the context (in L) - similar context (in T) conditions should reach the relearning criterion within the fewest number of trials, greatest number correct per trial and least number of errors per trial. The context (in L) - no context (in T) should result in the greatest number of trials, the least number of correct items per trial and the greatest number of errors per trial. The conditions in which a context (in L) and removal of one cue in retention is tested should situate themselves at an intermediate level.

In the present thesis it is likewise predicted that data recall should be best for no context (in L) - no context (in T) and/or context (in L) - similar context (in T) because cues available during learning are still present during retention. However, in the case of congruent cue conditions it is predicted that the removal of one cue or the other will not lead to detriment in recall due to the postulated stimulus equivalence. Only with the removal of both cues in retention should detriment occur. Consequently, recall should not differ significantly under context (in L) and removal of one cue in retention from the no context (in L) - no context (in T) nor the context (in L) similar context (in T). With incongruent cue conditions stimulus equivalence is not postulated. The no context (in L) - no context (in T) and/or the context (in L) - similar context (in T) should again result in the best recall. Context (in L) - no context (in T) should result in the poorest recall. With the removal of one cue in retention, recall should then depend on which was used as functional stimulus. Removal of one cue should not be detrimental, removal of the other should be detrimental and to the extent of the removal of both cues. It is predicted that word will be dominant and functional cue; therefore, context (in L) - word context (in T) should be better than context (in L) - color context (in T). The predictions on number correct per trial and

number of errors per trial may be logically deduced from the above predictions on recall and so are not enumerated.

The predictions of stimulus equivalence and cue selection for congruent and incongruent cue conditions respectively with the corresponding no cue conditions are formulated in hypotheses one to three. Hypothesis number four predicts that these principles should apply independently of the level of meaningfulness of materials. Consistency should therefore exist between both sets of congruent and incongruent conditions, A_1 and B_1 with A_2 and B_2 .

Recall Data. The results for the first trial, recall data, are plotted in Figure 4 according to learning and retention conditions. The mean recall scores according to learning conditions were 3.3, 3.45, 2.05, 2.4 and 4.2 for groups A_1 , A_2 , B_1 , B_2 , and C respectively. Recall was best for the control no context in learning condition followed by congruent conditions and poorest for incongruent conditions. When recall was plotted according to retention conditions, Figure 5, the means were 4.2, 4.08, 2.5, .4, and 4.2. No context (in L) - no context (in T), context (in L) - no context (in T) and context (in L) with removal of color cue only (in T) were better than the context (in L) - no context (in T) and context (in L) with removal of word cue only (in T). The fixed effects analysis of variance in

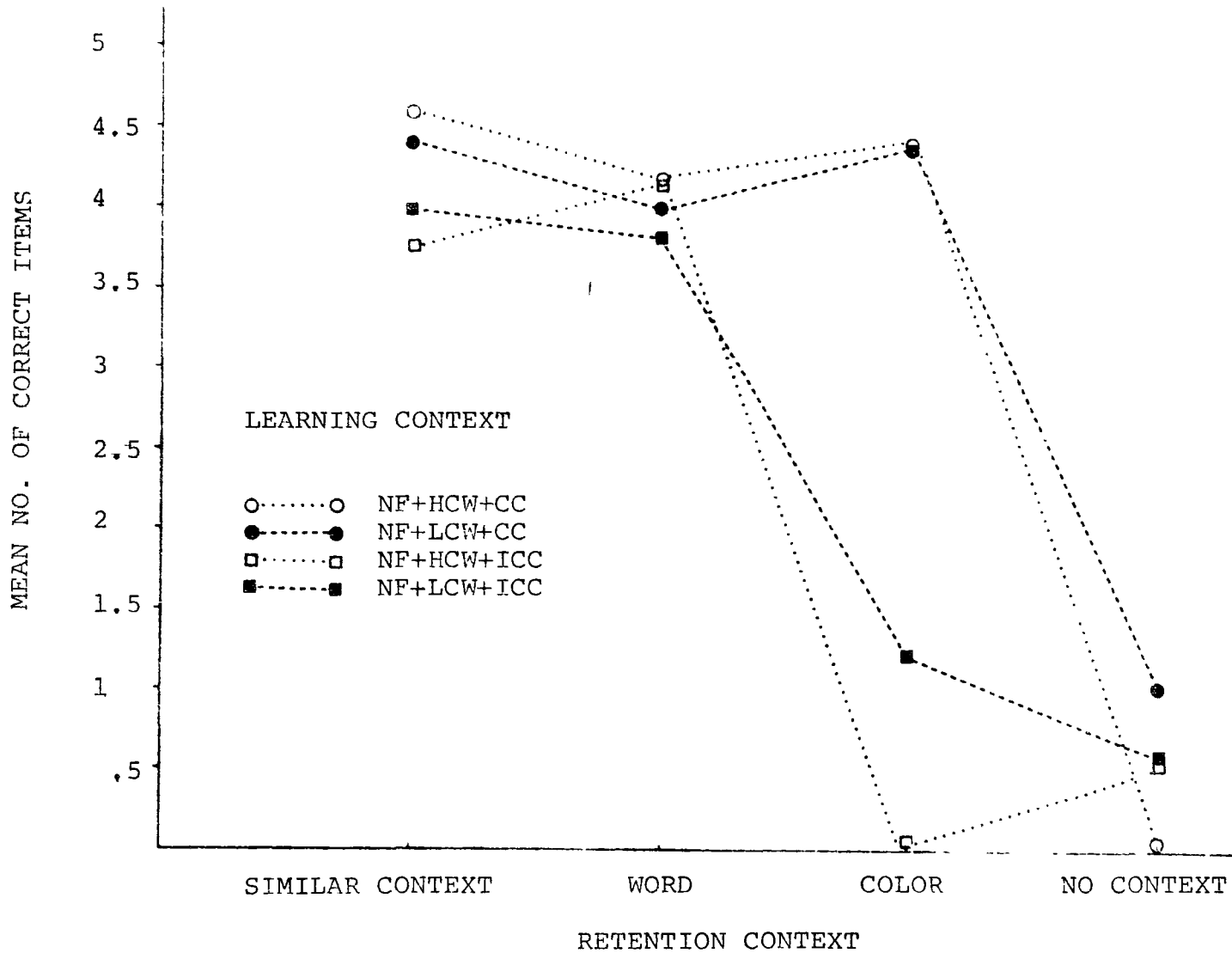


Fig. 4. Mean number of correct items recalled 24 hours after original learning as a function of learning and retention contexts.

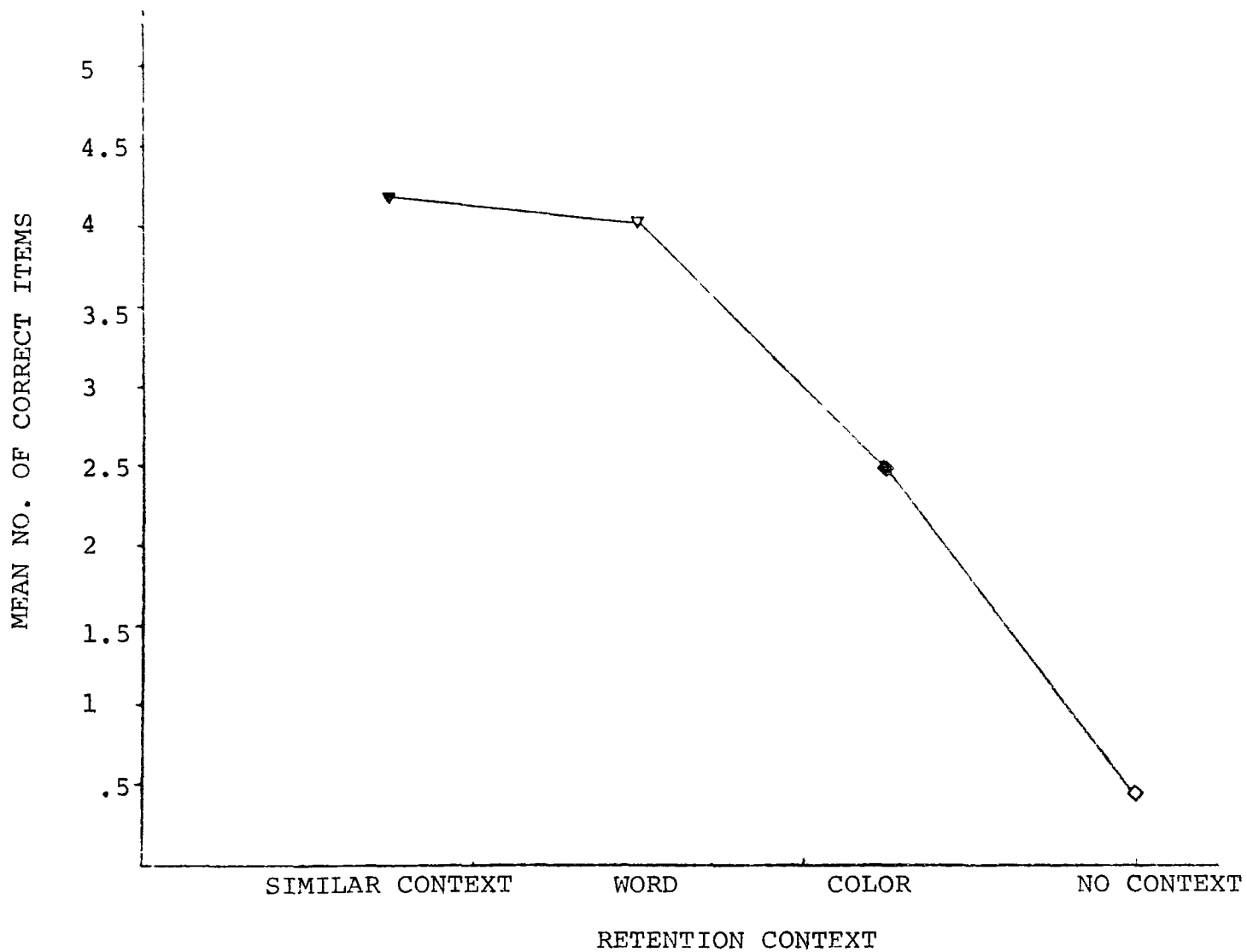


Fig. 5. Recall according to retention context.

Table IX shows that both the learning and retention context had significant effects. The interaction was also significant. The Newman-Keuls was computed on means according to learning variable, retention variable and level of retention variable in which removal of word or color only was tested. On the learning variable similar results as in original learning were found. Tested at the .05 level, the control no cue condition differed from the four experimental conditions. The congruent conditions differed significantly from incongruent cue conditions. On the retention variable the context (in L) - similar context (in T), the context (in L) - removal of color only (in T) and the no context (in L) - no context (in T) were alike but significantly different from context (in L) with removal of word only (in T) and also from context (in L) - no context (in T). When the Newman-Keuls was computed on conditions with removal of word cue only in retention, it was found that incongruent cue conditions resulted in a detrimental effect significantly different from congruent conditions at the .01 level.

Factors were investigated by a 2 x 2 x 4 factorial analysis of the experimental groups (Table X). The congruency factor and retention factor were significant beyond the .01 level ($F = 27.16$; 1 and 64 df: $P < .01$. $F = 61.35$; 1 and 64 df: $P < .01$). Meaningfulness was not significant

TABLE IX.- Summary of the Analysis of Variance for Recall.

Source	SS	df	MS	F
Learning Condition	17339.76	4	4334.94	16.01 ***
Retention Condition	39047.30	3	13015.77	48.07 ***
LXR	26107.45	12	2175.62	8.03 ***
Error	21659.40	80	270.74	
TOTAL	104153.91	99		

*** Significant at the .01 level.

TABLE X.- Summary of the Analysis of Variance on Experimental Groups for Recall.

Source	SS	df	MS	F
A (Meaningfulness)	456.03	1	456.03	1.72
B (Congruency)	7201.03	1	7201.03	27.16 ***
C (Retention)	48809.15	3	16269.72	61.35 ***
AB	108.09	1	108.09	-
AC	1303.82	3	434.61	1.64
BC	14020.02	3	4673.34	17.62 ***
ABC	931.76	3	310.59	1.17
Error (w)	16970.60	64	265.17	
TOTAL	89800.50	79		

*** Significant at the .01 level.

($F = 1.72$, 1 and 64 df: n.s.). Only the congruency X retention interaction was significant ($F = 17.62$; 3 and 64 df: $P < .01$). The predictions of equivalence, hypothesis number one, and of cue selection, hypothesis number two, were supported by the results of data recall.

Trials to Criterion in Relearning. The data for trials to criterion in relearning are presented in Figure 6. Marked differences are observed for conditions in which incongruent cue conditions (in L) were tested with color context only (in T). A greater number of trials were likewise required for all sub-groups subject to a context (in L) - no context (in T). Few trials were required in relearning for any condition in which the functional stimulus (in L) was still present (in T) either through original cue selection or through equivalence. The summary of the analysis of variance for trials to criterion (Table XI) revealed that retention, learning and the retention X learning interaction were significant. The Newman-Keuls indicated that on the learning variable the control differed significantly from the experimental conditions at the .05 level. On the retention variable, again the no context (in L) - no context (in T), context (in L) - similar context (in T) and context (in L) - word context only (in T) were alike and were significantly better than context (in L) - no context (in T) and context (in L) - color context only (in T). When cues present in learning were

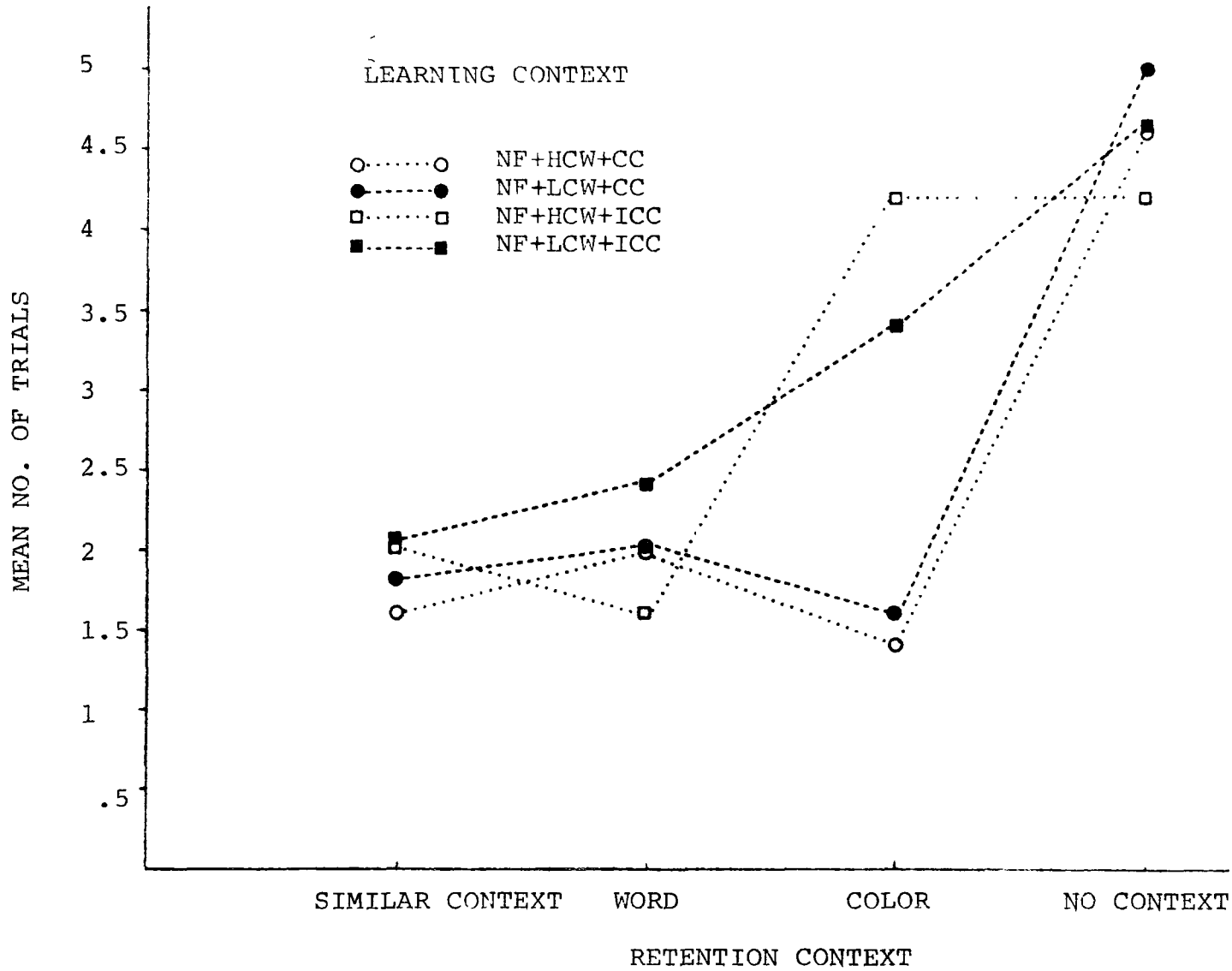


Fig. 6. Mean trials to criterion in relearning.

TABLE XI.- Summary of the Analysis of Variance for Trials to Criterion in Relearning.

Source	SS	df	MS	F
Retention Condition	76.84	3	25.61	32.01 ***
Learning Condition	21.76	4	5.44	6.8 ***
LXR	44.56	12	3.71	4.64 ***
Error	64.20	80	.80	
TOTAL	207.36	99		

*** Significant at the .01 level.

present during retention, relearning was facilitated. Only when both cues were removed or when word cue for incongruent conditions was removed did relearning require a greater number of trials. The relearning variable was again analyzed with a 2 x 2 x 4 factorial (Table XII). The congruency factor proved to be significant ($F = 33.71$; 3 and 64 df: $P < .01$) while the meaningfulness factor was not significant, $F < 1$. The retention factor was significant as well as congruency X retention, respectively ($F = 33.71$, 3 and 64 df: $P < .01$. $F = 76$; 3 and 64 df: $P < .01$).

Number Correct per Trial in Relearning. Only three trials were included in the analysis of number correct per trial in relearning because at this point the complete list had been relearned by most subjects. Figure 7 presents these results. No marked differences are observed between no context (in L) - no context (in T), context (in L) - similar context (in T) and context (in L) - word context only (in T) but these differ from context (in L) - no context (in T) and incongruent context (in L) - color context only (in T). The latter two conditions resulted in fewer number correct per trial. The mean number correct per trial was also plotted according to retention context regardless of learning context, Figure 8. Similar context and color context had a greater number correct per trial than

TABLE XII.- Summary of the Analysis of Variance on
Experimental Groups for Trials to
Criterion in Relearning.

Source	SS	df	MS	F
A (Meaningfulness)	.45	1	.45	-
B (Congruency)	6.05	1	6.05	6.37 *
C (Retention)	96.05	3	32.02	33.71 ***
AB	.05	1	.05	-
AC	1.65	3	.55	-
BC	21.65	3	7.22	7.6 ***
ABC	2.05	3	.68	-
Error (w)	61.00	64	.95	
TOTAL	188.95	79		

* Significant at the .05 level.

*** Significant at the .01 level.

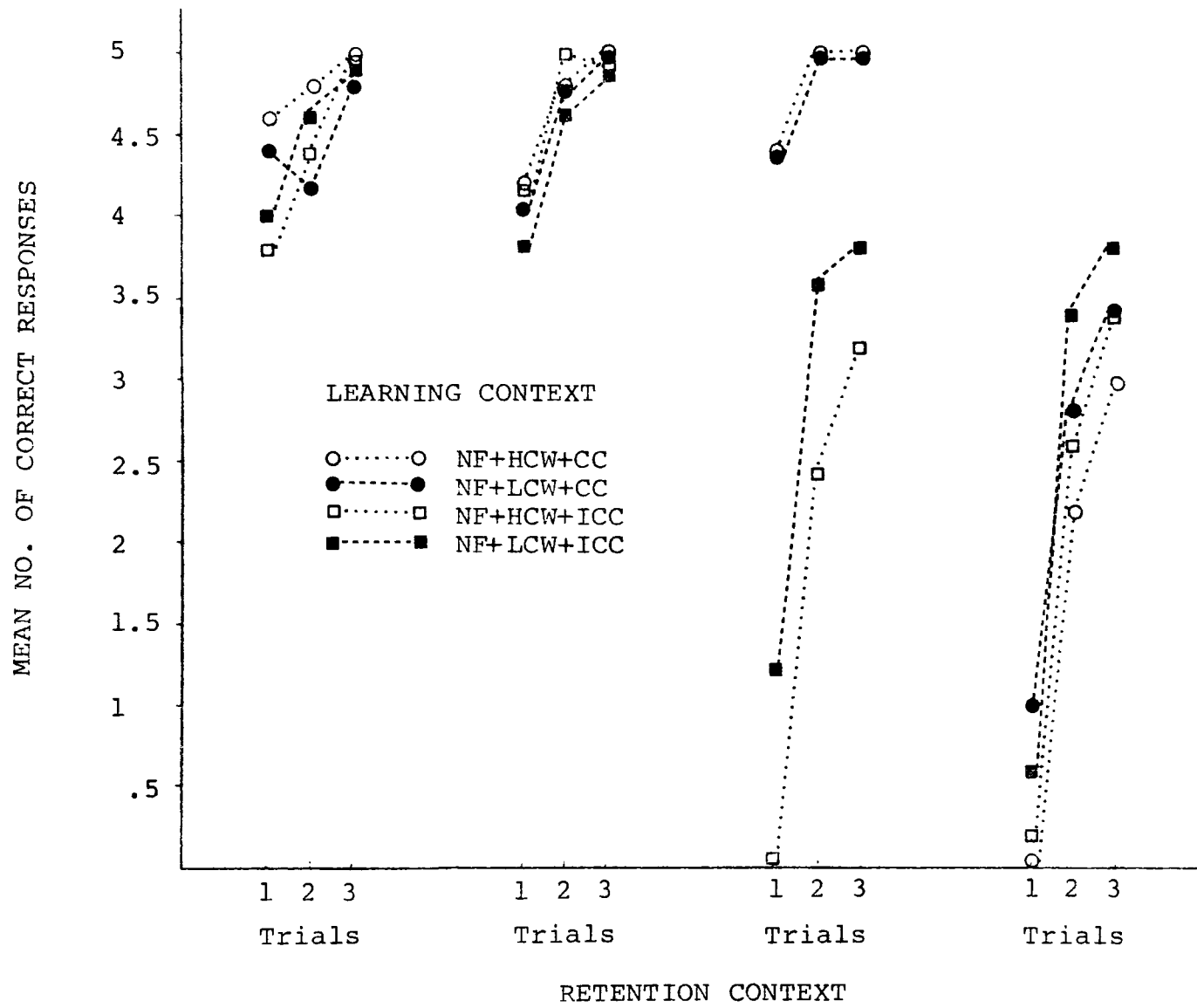


Fig. 7. Mean number of correct responses per trial in relearning.

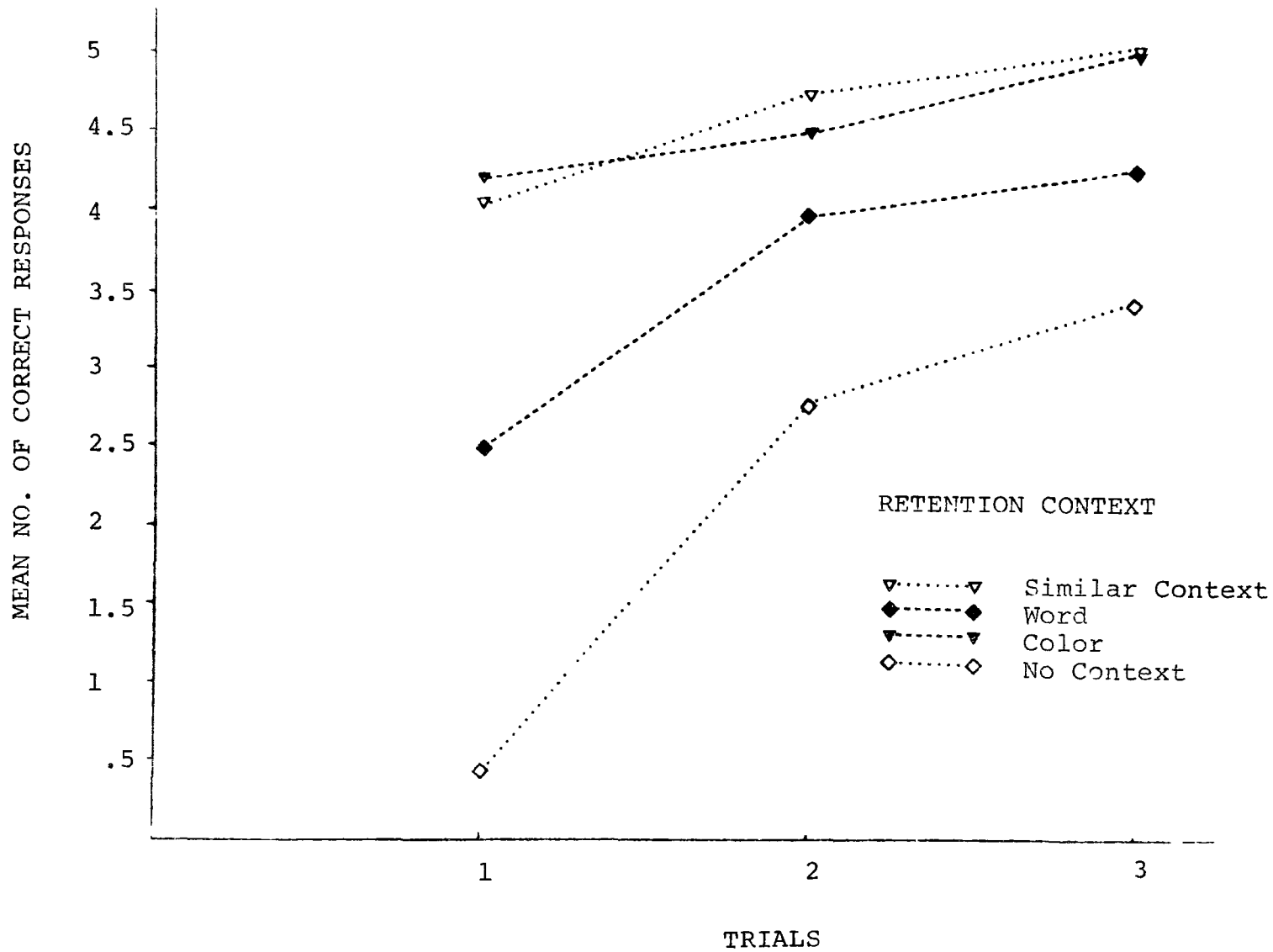


Fig. 8. Mean number of correct responses per trial according to retention context regardless of learning context.

the no context and word context conditions. The control no context (in L) - no context (in T) was alike to similar context and color context in retention.

Summary of the 5 x 4 x 3 factorial analysis with repeated measures on the last factor is represented in Table XIII. The main effects of learning, retention and trials were significant at the .01 level. The interactions of learning X retention and of trials X retention reached the .01 level and trials X learning the .05 level. The triple interaction, trials X learning X retention, was not significant. The Newman-Keuls revealed that on the learning variable the control no context (in L) - no context (in T) differed significantly from both of the incongruent groups. Congruent groups did not differ neither did incongruent groups. The rank order is exactly opposite of original learning. In original learning the no context condition was the poorest, congruent groups ranked second while incongruent groups performed the best. In relearning the no context condition was the best, congruent groups ranked second while incongruent groups were poorest. On the retention variable, no differences existed between context (in L) - similar context (in T), no context (in L) - no context (in T) and context (in L) - word context only (in T) but these measures differed beyond the .05 level from the context (in L) - no context (in T) and context (in L) -

TABLE XIII.- Summary of the Analysis of Variance for
Number Correct per Trial in Retention.

Source	SS	df	MS	F
<u>Between Subjects</u>	<u>138523.86</u>	<u>99</u>		
Learning Condition	21437.79	4	5359.45	23.42 ***
Retention Condition	59047.11	3	19683.37	86.01 ***
LXR	39731.76	12	3310.98	14.47 ***
Error (b)	18307.20	80	228.84	
<u>Within Subjects</u>	<u>85975.33</u>	<u>200</u>		
Trials	40744.25	2	20372.13	101.27 ***
TXL	3701.55	8	462.69	2.30 **
TXR	5386.63	6	897.77	4.46 ***
TXLXR	3957.70	24	164.90	
Error (w)	32185.20	160	201.16	
TOTAL	<u>224499.19</u>	<u>299</u>		

** Significant at the .025 level.

*** Significant at the .01 level.

color context only (in T). Incongruent cue conditions in which word was removed differed beyond the .05 level from congruent conditions in which word was removed. Congruent conditions were better than incongruent when word was eliminated during retention. In other words, with congruent cue conditions it did not matter whether color or word was removed; detrimental effects resulted only when both cues were eliminated. With incongruent cue conditions decrement did not occur with removal of color but did occur with removal of word cue. The effect of eliminating the word cue was equivalent to that of eliminating both cues. The results are consistent with those obtained for data recall and trials to criterion in relearning.

Factorial analysis of variance on the experimental groups was computed from a 2 x 2 x 4 x 3 with repeated measures on the last variable (Table XIV). From the between subjects variables the congruency factor and retention factor were significant. Congruency X retention interaction was also significant while meaningfulness factor was not significant. ($F = 24.23$; 1 and 64 df: $P < .01$. $F = 91.59$; 3 and 64 df: $P < .01$. $F = 26.92$; 3 and 64 df: $P < .01$. $F = 1$; 1 and 64 df: n.s.). The within subjects variable of trials was significant as expected. Congruency X trials interacted suggesting that profiles of number correct per trial were different for the incongruent and congruent groups.

TABLE XIV.- Summary of the Analysis of Variance on Experimental Groups for Number Correct per Trial in Relearning.

Source	SS	df	MS	F
<u>Between Subjects</u>	<u>123092.98</u>	<u>79</u>		
A (Meaningfulness)	453.75	1	453.75	1.69
B (Congruency)	6510.42	1	6510.42	24.53 ***
C (Retention)	73808.88	3	24602.96	91.59 ***
AB	176.81	1	176.81	-
AC	2055.42	3	685.14	2.55
BC	21690.48	3	7230.16	26.92 ***
ABC	1206.09	3	402.03	1.50
Subjects within groups	17191.13	64	268.61	
<u>Within Subjects</u>	<u>77984.67</u>	<u>160</u>		
D (Trials)	38709.98	2	19354.99	90.01 ***
AD	123.32	2	61.66	-
BD	2249.10	2	1124.55	5.23 ***
ABD	15.67	2	7.84	-
CD	6733.29	6	1112.21	5.22 ***
ACD	423.21	6	70.53	-
BCD	1938.10	6	323.02	1.05
ABCD	267.73	6	44.62	-
DX Subjects within groups	27524.27	128	215.03	
TOTAL	201077.65	239		

*** Significant at the .01 level.

Retention X trials also interacted suggesting that the patterns likewise differed according to retention context. ($F = 90.01$; 2 and 128 df: $P < .01$. $F = 5.23$; 2 and 128 df: $P < .01$. $F = 5.22$; 6 and 128 df: $P < .01$).

Number of Errors per Trial in Relearning. The average number of errors per trial for relearning are shown in Figure 9. Only three trials were again included in the analysis. No marked differences are noted for context (in L) - similar context (in T), context (in L) - word context (in T) and the control no context (in L) - no context (in T). Incongruent cue conditions produced a greater number of errors when tested for retention with color only than the congruent cue conditions when similarly tested. The context (in L) - no context (in T) resulted in the greatest number of errors. When mean number of errors per trial in relearning was plotted according to retention variable regardless of learning variable, Figure 10, context (in L) - no context (in T) showed the greatest number of errors, context (in L) - color context only (in T) ranked next while the context (in L) - similar context (in T), context (in L) - word context only (in T) and no context (in L) - no context (in T) were alike with the fewest errors.

A reciprocal square root transformation was performed on the raw error scores to correct for marked

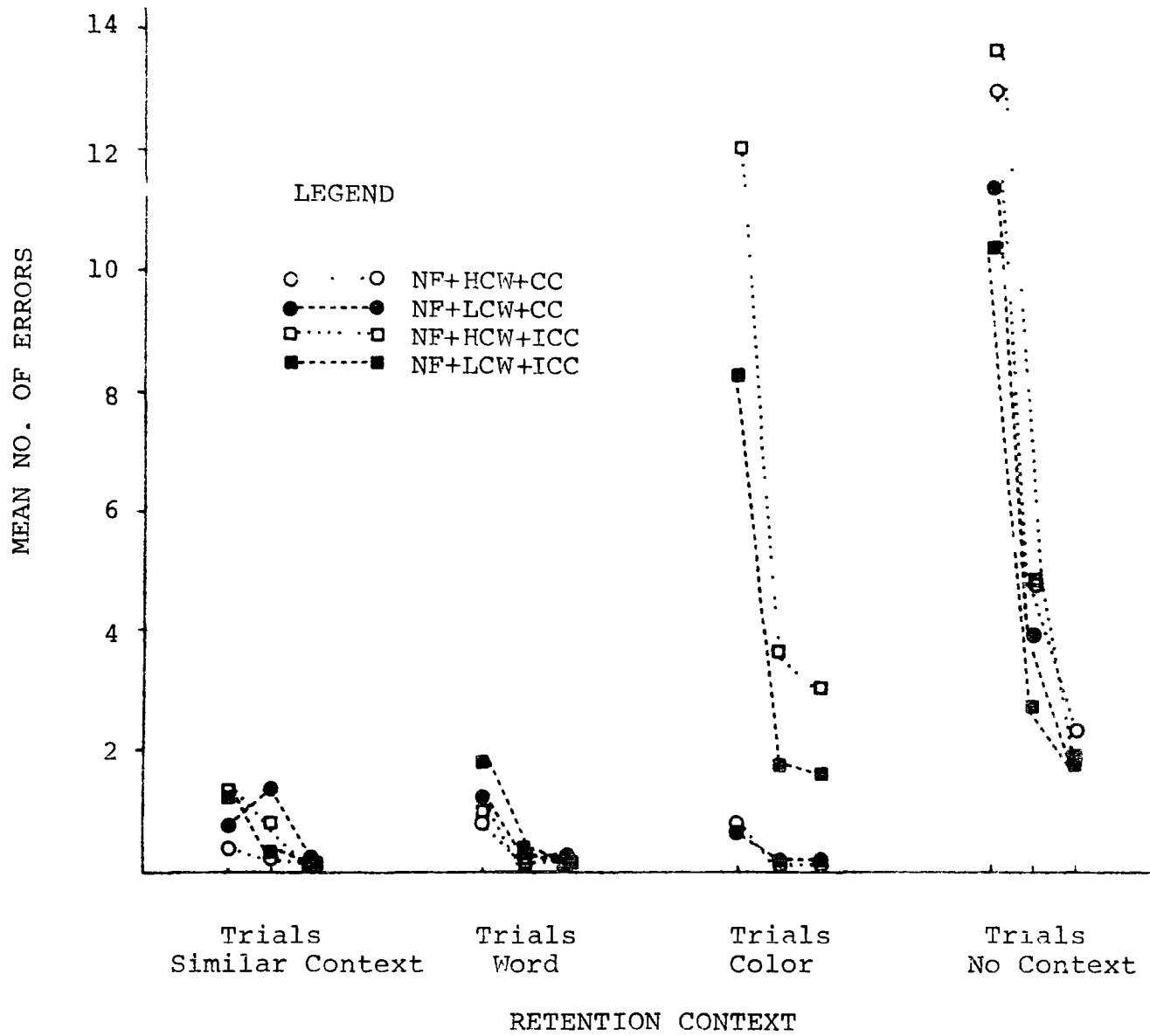


Fig. 9. Mean number of errors per trial in relearning.

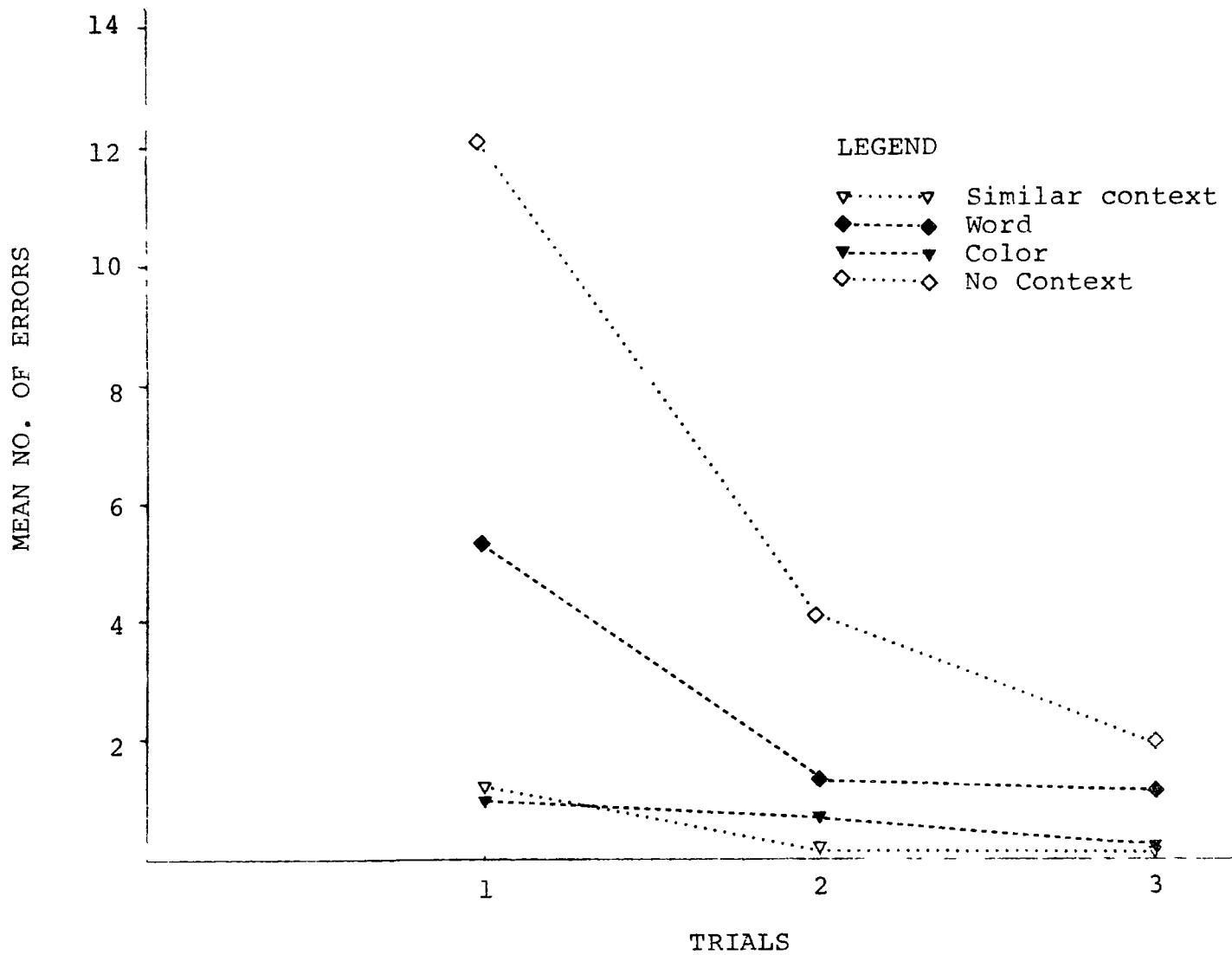


Fig. 10. Mean number of errors per trial according to retention context regardless of learning context.

positive skewness. The 5 x 4 x 3 fixed effects factorial analysis is presented in Table XV. Learning, retention and trials were significant. The interactions learning X retention, trials X learning, trials X retention and the triple interaction were also significant. The Newman-Keuls indicated that the differences previously noted on mean number of errors per trial according to learning variable, Figure 9, and according to retention variable, Figure 10, were significant beyond the .01 level. The additional comparison of cue conditions with context (in L) - color context only (in T) revealed that the congruency groups had significantly fewer errors, at the .01 level.

In order to discover the particular effects of factors, again the 2 x 2 x 4 x 3 factorial with repeated measures on the last factor was computed for the experimental groups (Table XVI). Results indicated that, of the between subjects variables, the congruency and retention factors were significant as well as congruency X retention ($F = 9.08$; 1 and 64 df: $P < .01$. $F = 31.55$; 3 and 64 df: $P < .01$. $F = 7.25$; 3 and 64 df: $P < .01$). Meaningfulness factor was not significant with $F < 1$. The within subject variable of trials was significant as expected ($F = 15.21$; 2 and 128 df: $P < .01$). None of the within subjects interactions were significant, suggesting that the within subjects interactions observed in Table XV were due to the

TABLE XV.- Summary of the Analysis of Variance for
Number of Errors per Trial in Relearning.

Source	SS	df	MS	F
<u>Between Subjects</u>	<u>16.113</u>	<u>99</u>		
Learning Condition	2.096	4	.524	8.06 ***
Retention Condition	5.604	3	1.868	28.74 ***
LXR	3.252	12	.271	4.17 ***
Error (b)	5.161	80	.065	
<u>Within Subjects</u>	<u>4.045</u>	<u>200</u>		
Trials	3.245	2	1.622	648.80 ***
TXL	.127	8	.016	6.40 ***
XR	.121	6	.020	8.00 ***
TXLXR	.137	24	.006	2.4 ***
Error (w)	.415	160	.0025	
TOTAL	20.158	299		

*** Significant at the .01 level.

TABLE XVI.- Summary of the Analysis of Variance on
Experimental Groups for Number of Errors
per Trial in Relearning.

Source	SS	df	MS	F
<u>Between Subjects</u>	<u>14.2736</u>	<u>79</u>		
A (Meaningfulness)	.0058	1	.0058	-
B (Congruency)	.6717	1	.6717	9.08 ***
C (Retention)	7.0052	3	2.3351	31.55 ***
AB	.0064	1	.0064	-
AC	.1310	3	.0437	-
BC	1.6099	3	.5367	7.25 ***
ABC	.1101	3	.0367	-
Subjects within groups	4.7335	64	.0740	
<u>Within Subjects</u>	<u>15.2611</u>	<u>160</u>		
D (Trials)	2.8625	2	1.4312	15.21 ***
AD	.0019	2	.0009	-
BD	.0899	2	.0449	-
ABD	.0003	2	.0001	-
CD	.1570	6	.0262	-
ACD	.0338	6	.0056	-
BCD	.0423	6	.0071	-
ABCD	.0295	6	.0049	-
DX Subjects within groups	12.0439	128	.0941	
TOTAL	29.5347	239		

*** Significant at the .01 level.

no context (in L) - no context (in T) control group.

CHAPTER IV

DISCUSSION OF RESULTS

In general, it is said that cues are additive when S's can master a problem with two relevant cues (either of which can be used to solve the problem) more rapidly than a problem with only one relevant cue. The implication is that the two cues "add" in some manner. However, since stimulus selection may depend on the nature and relative strengths of the stimulus compounds it is possible that a strictly additive model does not always apply. Alternatively, if a subjective or weighted model applies the following possibilities exist: there may be cases in which two contextual cues are perceived as one and both cues serve as functional stimuli; two contextual cues may be perceived distinctively with only one used as functional stimulus; and, two contextual cues may be perceived distinctively while both are being used as functional stimuli with different weights. Moreover there may be cases in which two contextual cues facilitate learning but to a lesser degree than only one cue. In the present experiment, with contextual cues being congruent (e.g., the word red printed in the appropriate color red) and incongruent (e.g., the word red printed in blue ink), a subjective or weighted model was expected to apply. The first

postulation was that with congruent cues an equivalence of stimuli would occur so that either one cue and/or the other would serve as functional stimulus. During recall only the removal of both congruent cues would lead to detriment. According to an additive model of the stimulus selection hypothesis, removing one cue should cause a decrement in retention and removing both an even greater decrement.

For incongruent cues it was postulated that only one particular cue would be selected. Recall should conform to the stimulus selection hypothesis with detriment caused by removal of the functional stimulus. Color word rather than the color of print was expected to be selected.

Hypothesis number three (3) stated that the contextual cues would facilitate recall as compared to a control having no contextual cues. Hypotheses were not formulated on the learning phase of this experiment for reasons stated later in the discussion.

Finally, in hypothesis four (4) it was predicted that the phenomena of equivalence and of cue selection would still apply with another set of similar but less familiar stimulus compounds.

The learning data for all three measures showed that learning is enhanced by the use of contextual cues. The results for mean number of trials to reach learning

criterion additionally revealed that congruent cues facilitate learning significantly better than incongruent cues. It may justifiably be argued that congruent cues constructed of the names of colors printed in their appropriate colors are in no way "disjointed" cues and therefore exist as but one cue. This was precisely the author's intention in his choice of stimulus elements. If the congruent cues are viewed as but one cue, then the incongruent cues must necessarily be viewed as two "disjointed" cues for they lead to the concept of two different colors. From the standpoint of an additive model, incongruent cues should lead to greater learning facilitation than congruent cues. It was found however that incongruent cues produced less facilitation.

The analysis of variance on mean number of trials to reach learning criterion revealed that the congruency factor was significant while meaningfulness (familiarity) factor was not significant. Congruent cues being of a consonant nature, selection of the functional stimulus may be easily accomplished, whereas, incongruent cues, being of a dissonant nature, may cause interference and increased difficulty of cue selection. These results do not contradict the additive model but simply support the view that a subjective model sometimes applies as a consequence of the nature of the contextual cues.

A word of caution is required with the interpretation of the meaningfulness factor in the present experiment. The level of meaningfulness of cues is known to be influential in cue selection. The review of the literature substantiated this fact. The present experiment was designed to test whether or not the phenomena investigated would also apply with another set of similar yet less familiar set of cues. The sets of cues were arbitrarily chosen as possibly being at two different levels of familiarity. Operationally defined, one set of five (5) cues was randomly chosen from the eight basic colors which were judged by E as being familiar colors. The second set was randomly chosen from remaining colors as being less familiar colors. The lack of a significant effect due to meaningfulness (level of familiarity) may simply denote no significant difference between the two sets of cues in terms of their familiarity to subjects. The question as to whether the present findings may be generalized to any type and/or different levels of meaningfulness of congruent and incongruent cues is not answered.

The measures of number correct per trial and number of errors per trial also showed that in agreement with the stimulus selection hypothesis contextual cues facilitate learning. The analysis of variance revealed no significant differences between the congruent cue and

incongruent cue learning conditions. The congruency factor and meaningfulness factor were not significant as reflected by these two learning measurements. Although hypotheses were not formulated with respect to these measurements, to have unequivocally supported the author's expectations the congruency factor should have been significant in learning. There are two possible reasons why the difference between congruent and incongruent conditions were not significant on number correct per trial and number of errors per trial: the high variability among S's and/or the occurrence of cue selection by incongruent groups at an early stage of learning. Since only five items were used and due to the nature of the adjusted learning technique (which as in the present study has as primary purpose to control for overlearning when retention is the center of investigation) the results are not discordant. This possible outcome had been anticipated and accounts for the fact that hypotheses were formulated only with respect to the retention phase of the experiment.

The testing of hypotheses were derived from retention. Recall and relearning data were viewed from the aspects of learning context and retention context. Under both viewpoints compatibility existed for all four measures. When viewed from the learning variable, recall was best under the no-context condition with congruent cue conditions

at an intermediate level of detriment while incongruent cues resulted in the poorest performance. According to the retention variable, detriment with congruent cues occurred only when both cues were removed. For incongruent cues detriment occurred when the cue word was removed but not when the cue color was removed. Whenever both cues were removed recall was practically nil. The first general conclusion supports the stimulus selection hypothesis in that contextual cues do enhance learning and retention.

The hypothesis of stimulus equivalence for congruent conditions in which cues consisted of color words and their respective colors was also substantiated. During recall the removal of one congruent cue did not cause a detriment. Only the removal of both congruent cues affected retention significantly. These results are similar to those obtained by Swede and McNulty¹ who utilized contextual cues of shape plus color. In both the former and present experiments, either cue was capable of eliciting the correct response in retention. If, as the stimulus selection hypothesis predicates, S's choose but one cue for response elicitation, then in the present experiment as well as in that of Swede and McNulty a stimulus equivalence or a mediational

¹ George Swede and John A. McNulty, "The Influence of Contextual Cues upon the Learning and Retention of Paired-Associates", Canadian Journal of Psychology, Vol. 21, No. 5, 1967, p. 394-408.

process must have operated. The only other apparent alternative is that both cues were independently selected as functional stimuli. A tentative interpretation, not contradictory but complementary to the stimulus selection hypothesis, is that depending on the nature and relative strengths of cues one and/or the other may serve as functional stimulus.

The data for incongruent cue conditions were compatible to the predictions of the stimulus selection hypothesis. When contextual cues consisted of names of colors printed with inappropriate ink colors, S's chose the names of colors as functional stimuli. Saufley and Underwood² with a somewhat similar content in transfer tests found similar results. They suggested that the selection of the names may be due to the dominant habit of responding to words. The effect of removing the name of the color was detrimental and comparable to that of removing both cues. When only the contextual cue of color was removed no detriment occurred. Recall in the latter case was as efficient as conditions in which all stimuli present during original learning were still available during retention. Particular to the present experiment is the fact that the

² William H. Saufley and Benton J. Underwood, "Cue Selection Interference in Paired-Associate Learning", Journal of Verbal Learning and Verbal Behavior, Vol. 3, No. 6, 1964, p. 474-497.

stimulus compounds utilized were of such a nature as to provide a possible outlet if the cognitive dissonance or interference caused by incongruent contextual cues was too potent. This outlet was the use by S's of random shapes having associational values of twenty-eight percent. For five S's from each of the incongruent groups it was feasible to discover whether such a phenomenon occurred. Since these S's were tested for retention with removal of both contextual cues, efficient recall would indicate that the random shapes had been selected as functional stimuli during learning. Based on this criterion, an inspection of the data revealed that only one subject from a total of 10 resorted to the selection of random shapes in an attempt to overcome interference.

The three measures of relearning (trials to criterion, number correct per trial and number of errors per trial) provided similar results to those of data recall. When viewed from the point of the learning variable, relearning was best under conditions in which cues available during original learning were still available either through stimulus equivalence or cue selection. These groups required significantly less trials, had a significantly greater number correct per trial and significantly less errors per trial. According to the retention variable, only six (6) of the sixteen (16)

experimental sub-groups demonstrated poor performance in recall: the four (4) sub-groups in which a context (in L)-no context (in T) was tested and the two (2) sub-groups having incongruent context (in L) with removal of word cue (in T).

Of the two learning factors, congruency appears to have accounted for the greater part of the variance during relearning. The level of familiarity of the two sets of cues utilized showed no differential effects. Stimulus equivalence and cue selection followed the same patterns when tested with the two different sets of cues.

Although mean number of errors per trial is considered as an independent measure from mean number correct per trial, both gave compatible results. It would appear, however, from the present study that number of errors per trial, when using the adjusted learning technique, is subject to a much greater variability than number correct per trial.

The stimulus selection hypothesis which predicts that learning and retention are facilitated by means of contextual cues was substantiated. The present study however suggests that the nature of the stimulus compounds may determine whether an additive model or weighted model applies. With two congruent contextual cues, one and/or the other may serve as functional stimulus through a

process of mediation or stimulus equivalence. With two incongruent contextual cues one cue is chosen as functional stimulus. Of the two types of incongruent cues used in the present study the names of colors were selected in preference to ink colors. Two cues were not more facilitating to learning and retention than one cue. The interpretation is that with the particular cues utilized in the present experiment a predominantly subjective or weighted model applied.

SUMMARY AND CONCLUSION

The present study was designed to determine the effects of congruent and incongruent contextual cues on the learning and retention of paired-associates.

A paired-associate learning - retention paradigm was used to test the hypotheses of stimulus equivalence for congruent cues and of stimulus selection for incongruent cues. To this purpose, contextual cues were constructed of names of colors and ink colors. Random shapes contoured by the contextual cues served as stimulus terms. Responses consisted of nonsense syllables. A total of 100 student nurses were randomly assigned into 16 groups of five subjects each according to a 2 x 2 x 4 factorial design and were compared to a control group of twenty subjects. The learning variable consisted of two factors each at two levels: (High Meaningfulness - Low Meaningfulness and Congruency-Incongruency). The retention variable tested for recall and relearning with similar context, color context, word context and no context (in L) - no context (in T) condition. The results were analyzed in terms of trials to criterion, number correct per trial, number of errors per trial and recall.

On all measures the analyses of variance indicated that learning was facilitated by contextual cues. Removal of one congruent cue did not hinder retention. The

hypothesis of stimulus equivalence was supported in that only the removal of both congruent cues led to recall detriment. The hypothesis on stimulus selection for incongruent cues was also supported. Detriment in recall occurred only when word context or both word context plus color context was/were removed. Subjects chose names of colors in preference to colors as functional stimuli. These latter results were compatible to the stimulus selection hypothesis. However, since incongruent cues were found not to be more facilitating than congruent cues, a strictly additive model of cue selection was rejected. Alternatively, it was suggested that a subjective or weighted model of stimulus selection may apply as a consequence of the nature of the contextual cues utilized. Parallel results were obtained when a second set of similar but less familiar contextual cues were tested. The results were finally discussed in reference to related findings.

In summary, it can be concluded that learning is facilitated by specific contextual cues. With the particular materials in the present experiment, stimulus equivalence occurred for congruent cues while stimulus selection of names of colors in preference to colors occurred for incongruent cues. This led to a second conclusion, namely, that a subjective or weighted model

may apply to cue selection. The evidence, although tentative, also indicated that two contextual cues are not always more facilitating than one.

The implications of these findings are such as to warrant caution in the choice of attention-getting cues as aids for creating a more productive or efficient learning environment. Danger may exist in assuming an additive enrichment from combinations of cues for which increased learning efficiency has been established but for each cue individually.

Further research on the mediational processes and their effects on learning for various compounds of congruent and incongruent contextual cues are recommended. Attempts could be made to quantify the nature and relative response strengths of various components, with manipulation of the subjective parameters of vividness, interest, preference, and meaningfulness for consonant and dissonant combinations.

It is recommended that additional testing of functional stimulus equivalence be accomplished by means of the adjusted learning technique in combination with a design using trials as a between-subjects variable. At the termination of each trial, a component(s) transfer test would reveal whether the elements were learned simultaneously or successively.

BIBLIOGRAPHY

Archer, E. James, "A Re-evaluation of the Meaningfulness of All Possible CVC Trigrams", Psychological Monograph, Vol. 74, No. 10 (Whole No. 497), 1960, p. 1-23.

A very popular source for CVC trigrams. Response items of the present experiment were selected from this source.

Madden, Marian S., Jack A. Adams and Shirley A. Spence, "Memory-Drum versus Adjusted Learning Techniques in the Study of Associative Interference in Learning by Paired-Associates", American Journal of Psychology, Vol. 63, No. 2, 1950, p. 186-195.

Defends on experimental and logical grounds the need for the use of the adjusted learning technique in studies concerned with differences in individual susceptibility to interference effects. The technique was utilized.

Saufley, William H. and Benton J. Underwood, "Cue Selection Interference in Paired-Associate Learning", Journal of Verbal Learning and Verbal Behavior, Vol. 3, No. 6, 1964, p. 474-479.

A study on cue selection interference. Influential in experimenter's choice of contextual cues as being names of colors and ink colors.

Stroop, J. R., "Studies of Interference in Serial Verbal Reactions", Journal of Experimental Psychology, Vol. 18, No. 6, 1935, p. 643-662.

A study on interference of conflicting stimuli consisting of a name of one color printed in the ink of another color. Stroop's concept served in the construction of contextual cues.

Sundland, Donald M. and Delos D. Wickens, "Context Factors in Paired-Associate Learning and Recall", Journal of Experimental Psychology, Vol. 63, No. 3, 1962, p. 302-306.

Noted as one of the most important researches on contextual cues. Discusses at length the interactions between cues and suggests certain controls.

Swede, George and John A. McNulty, "The Influence of Contextual Cues upon the Learning and Retention of Paired-Associates", Canadian Journal of Psychology, Vol. 21, No. 5, 1967, p. 394-408.

Found results suggesting a modification to the stimulus selection hypothesis. The research which most directly stimulated the present one.

Vanderplas, James M. and Everett A. Garvin, "The Association Value of Random Shapes", Journal of Experimental Psychology, Vol. 57, No. 3, 1959, p. 147-154.

Established the association value, content, and heterogeneity of responses for one hundred and eighty random shapes of varying complexity. Served in the selection of materials.

Weiss, Walter and Garry Margolius, "The Effect of Context Stimuli on Learning and Retention", Journal of Experimental Psychology, Vol. 48, No. 5, 1954, p. 318-322.

The pioneer study on the effects of contextual cues. Has stimulated much research.

APPENDIX I

INSTRUCTIONS TO SUBJECTS

1. Learning Instructions.

This is an experiment on learning. You will be required to learn five (5) paired-associates. Here is an example of a paired-associate task (Show subject a card with S - R on it). At this point, an enumeration of the components particular to S's group was given.

The cards are placed in this machine and are viewed one at a time through this aperture (point to it). The machine will be regulated in such a way as to show the stimulus side (point to it) alone for two (2) seconds. During this time you will be required to study the stimulus so as to be able to give the response before it appears on the right hand side of the aperture. (pause) Naturally on the first trial you will be unable to give the response so you will simply attempt to learn the paired-associates during this trial. Both the stimulus and response will be shown together for two (2) seconds. Both shutters of the aperture will then close for three (3) seconds. Another card will then appear, etc. On the second trial, if you give the correct response before it appears, it will be counted as correct. Everytime you give the correct

nonsense syllable (response) I will remove from the learning task the card or cards you had correct. On the next trial I will present only those you had wrong. This method will continue until there are no cards left to show. Then the five (5) cards will be presented again and the same procedure will be followed. Only when you can give the five (5) responses correctly in one trial will the task be over.

In order to avoid your learning the responses in a specific order, I will "mix-up" the cards after each trial. This may make the task difficult, so try your best at all times. Please spell the response (nonsense syllable) in a clear loud voice.

With these two S - R marked cards I will show you how the apparatus works and review the instructions with you (Demonstrate procedure). Do you have any questions?

The actual task will now begin.

2. Retention and Relearning Instructions

Yesterday you learned five (5) paired-associates. To-day essentially the same paired-associates will be shown again. There may possibly be some changes in the stimulus terms, however, the response terms are exactly the same as yesterday's responses. Yesterday you were given one trial to study the paired-associates before attempting to give the correct responses. To-day, you will try to get as many

correct as you can on the first trial, that is, the task will begin immediately. The procedure of removing correctly anticipated responses will be the same and will continue until you have relearned the five (5) nonsense syllables. Try to do your best from the start. Do you have any questions?

The task will now begin.

APPENDIX 2

STIMULUS-RESPONSE ITEMS IN LEARNING

Appendix 2 consists of the items utilized in the learning conditions. Column 1 indicates the learning conditions which correspond to:

- Group A₁: Congruent Cues plus High Meaningfulness
- Group A₂: Congruent Cues plus Low Meaningfulness
- Group B₁: Incongruent Cues plus High Meaningfulness
- Group B₂: Incongruent Cues plus Low Meaningfulness
- Group C: No Contextual Cues

Column 2 presents the number of the random shapes selected from those of an eight point complexity level (Vanderplas and Garvin)¹. Column 3 and column 4 list the color words and color respectively which together comprise the contextual cues. Columns 2, 3, and 4 together constitute the nominal stimulus. Column 5 lists the nonsense syllables used as response terms. Each row corresponds to the combinations of materials presented per card for a given learning condition.

¹ James M. Vanderplas and Everett A. Garvin, "The Association Value of Random Shapes", Journal of Experimental Psychology, Vol. 57, No. 3, 1959, p. 147-154.

GROUP	RANDOM SHAPE	COLOR WORD	COLOR	RESPONSE
A ₁	# 23	Orange	Orange	XUC
	# 22	Brown	Brown	HIJ
	# 26	Red	Red	VUF
	# 24	Blue	Blue	QIW
	# 21	Green	Green	ZOQ
A ₂	# 23	Gray	Gray	XUC
	# 22	Violet	Violet	HIJ
	# 26	Yellow	Yellow	VUF
	# 24	Pink	Pink	QIW
	# 21	Purple	Purple	ZOQ
B ₁	# 23	Orange	Gray	XUC
	# 22	Brown	Violet	HIJ
	# 26	Red	Yellow	VUF
	# 24	Blue	Pink	QIW
	# 21	Green	Purple	ZOQ
B ₂	# 23	Gray	Orange	XUC
	# 22	Violet	Brown	HIJ
	# 26	Yellow	Red	VUF
	# 24	Pink	Blue	QIW
	# 21	Purple	Green	ZOQ
C	# 23	-	-	XUC
	# 22	-	-	HIJ
	# 26	-	-	VUF
	# 24	-	-	QIW
	# 21	-	-	ZOQ

APPENDIX 3

STIMULUS-RESPONSE ITEMS IN RETENTION

Appendix 3 consists of the items utilized in the retention conditions. The initial letter in column 1 indicates the original learning condition while the second letter indicates the retention conditions which correspond to the following sub-groups:

- A: Similar Context as in Original Learning
- B: Color Context Only
- C: Word Context Only
- D: No Contextual Cues

Column 2 presents the number of the random shapes selected. Column 3 indicates the name of the color word, printed in black ink in the condition of word context only. Column 4 indicates the colored frame utilized in the condition of color context only. Column 5 lists the nonsense syllables used as response terms. Each row corresponds to the combination of materials presented per card for a given retention condition. The control group was tested during retention, as in original learning, without contextual cues.

GROUP	RANDOM SHAPE	COLOR WORD	COLOR	RESPONSE
A ₁ - A	# 23	Orange	Orange	XUC
	# 22	Brown	Brown	HIJ
	# 26	Red	Red	VUF
	# 24	Blue	Blue	QIW
	# 21	Green	Green	ZOQ
A ₁ - B	# 23	Orange	--	XUC
	# 22	Brown	-	HIJ
	# 26	Red	-	VUF
	# 24	Blue	--	QIW
	# 21	Green	-	ZOQ
A ₁ - C	# 23	-	Orange	XUC
	# 22	-	Brown	HIJ
	# 26	-	Red	VUF
	# 24	-	Blue	QIW
	# 21	-	Green	ZOQ
A ₁ - D	# 23	-	-	XUC
	# 22	-	-	HIJ
	# 26	-	-	VUF
	# 24	-	-	QIW
	# 21	-	-	ZOQ

GROUP	RANDOM SHAPE	COLOR WORD	COLOR	RESPONSE
A ₂ - A	# 23	Gray	Gray	XUC
	# 22	Violet	Violet	HIJ
	# 26	Yellow	Yellow	VUF
	# 24	Pink	Pink	QIW
	# 21	Purple	Purple	ZOQ
A ₂ - B	# 23	Gray	-	XUC
	# 22	Violet	-	HIJ
	# 26	Yellow	-	VUF
	# 24	Pink	-	QIW
	# 21	Purple	-	ZOQ
A ₂ - C	# 23	-	Gray	XUC
	# 22	-	Violet	HIJ
	# 26	-	Yellow	VUF
	# 24	-	Pink	QIW
	# 21	-	Purple	ZOQ
A ₂ - D	# 23	-	-	XUC
	# 22	-	-	HIJ
	# 26	-	-	VUF
	# 24	-	-	QIW
	# 21	-	-	ZOQ

GROUP	RANDOM SHAPE	COLOR WORD	COLOR	RESPONSE
B ₁ - A	# 23	Orange	Gray	XUC
	# 22	Brown	Violet	HIJ
	# 26	Red	Yellow	VUF
	# 24	Blue	Pink	QIW
	# 21	Green	Purple	ZOQ
B ₁ - B	# 23	Orange	-	XUC
	# 22	Brown	-	HIJ
	# 26	Red	-	VUF
	# 24	Blue	-	QIW
	# 21	Green	-	ZOQ
B ₁ - C	# 23	-	Gray	XUC
	# 22	-	Violet	HIJ
	# 26	-	Yellow	VUF
	# 24	-	Pink	QIW
	# 21	-	Purple	ZOQ
B ₁ - D	# 23	-	-	XUC
	# 22	-	-	HIJ
	# 26	-	-	VUF
	# 24	-	-	QIW
	# 21	-	-	ZOQ

GROUP	RANDOM SHAPE	COLOR WORD	COLOR	RESPONSE
B ₂ - A	# 23	Gray	Orange	XUC
	# 22	Violet	Brown	HIJ
	# 26	Yellow	Red	VUF
	# 24	Pink	Blue	QIW
	# 21	Purple	Green	ZOQ
B ₂ - B	# 23	Gray	-	XUC
	# 22	Violet	-	HIJ
	# 26	Yellow	-	VUF
	# 24	Pink	-	QIW
	# 21	Purple	-	ZOQ
B ₂ - C	# 23	-	Gray	XUC
	# 22	-	Violet	HIJ
	# 26	-	Yellow	VUF
	# 24	-	Pink	QIW
	# 21	-	Purple	ZOQ
B ₂ - D	# 23	-	-	XUC
	# 22	-	-	HIJ
	# 26	-	-	VUF
	# 24	-	-	QIW
	# 21	-	-	ZOQ

APPENDIX 4

RAW DATA FOR LEARNING

Appendix 4 presents the raw data for learning. The S's number indicates the order in which subjects appeared for the experiment. The learning data include frequencies for number of trials to reach learning criterion, number correct per trial and number of errors per trial. The learning conditions represented are:

- Group A₁ : Congruent Cues plus
High Meaningfulness
- Group A₂ : Congruent Cues plus
Low Meaningfulness
- Group B₁ : Incongruent Cues plus
High Meaningfulness
- Group B₂ : Incongruent Cues plus
Low Meaningfulness
- Group C : No Contextual Cues

Total number of errors in learning are included for observational purposes.

APPENDIX 5

RAW DATA FOR RECALL AND RELEARNING

Appendix 5 presents the raw data for recall and relearning. The initial letter in column 2 indicates the original learning condition. The S's are sub-grouped according to the retention context in which they were tested. Sub-divisions A, B, C and D represent respectively retention conditions: Similar Context, Color Context, Word Context and No Context. The Control Group C is not sub-divided as it was tested in the no context (in L) - no context (in T) condition. The data include frequencies for data recall, number of trials to reach relearning criterion, number correct per trial in relearning and number of errors per trial in relearning. Total number of errors in relearning are included for observational purposes.

GROUP A₁

S'S NO.	CONDITION	DATA RECALL	NO. T	NO. CORRECT PER TRIAL							NO. E	NO. OF ERRORS PER TRIAL						
				1	2	3	4	5	6	7		1	2	3	4	5	6	7
12	A ₁ - A	04	03	04	04	05				02	01	01	00					
32	A ₁ - A	05	01	05						00	00							
41	A ₁ - A	05	01	05						00	00							
78	A ₁ - A	05	01	05						00	00							
97	A ₁ - A	04	02	04	05					01	01	00						
01	A ₁ - B	04	02	04	05					01	01	00						
40	A ₁ - B	04	03	04	04	05				02	01	01	00					
55	A ₁ - B	05	01	05						00	00							
69	A ₁ - B	04	02	04	05					01	01	00						
86	A ₁ - B	04	02	04	05					02	02	00						
06	A ₁ - C	05	01	05						00	00							
21	A ₁ - C	05	01	05						00	00							
57	A ₁ - C	03	02	03	05					02	02	00						
73	A ₁ - C	05	01	05						00	00							
83	A ₁ - C	04	02	04	05					02	02	00						
20	A ₁ - D	00	06	00	02	04	04	03	05	22	15	03	01	01	02	00		
29	A ₁ - D	00	04	00	00	02	05			24	12	08	04	00				
48	A ₁ - D	00	04	00	03	04	05			28	20	07	01	00				
61	A ₁ - D	00	05	00	03	01	03	05		16	08	02	04	02	00			
93	A ₁ - D	00	04	00	03	04	05			16	10	04	02	00				

GROUP A₂

S's NO.	CONDITION	DATA RECALL	NO. T	NO. CORRECT PER TRIAL							NO. E	NO. OF ERRORS PER TRIAL						
				1	2	3	4	5	6	7		1	2	3	4	5	6	7
07	A ₂ - A	03	04	03	01	04	05				11	03	07	01	00			
31	A ₂ - A	04	02	04	05						01	01	00					
56	A ₂ - A	05	01	05							00	00						
67	A ₂ - A	05	01	05							00	00						
94	A ₂ - A	05	01	05							00	00						
17	A ₂ - B	04	03	04	04	05					02	01	01	00				
28	A ₂ - B	04	02	04	05						01	01	00					
54	A ₂ - B	04	02	04	05						01	01	00					
62	A ₂ - B	05	01	05							00	00						
85	A ₂ - B	03	02	03	05						03	03	00					
14	A ₂ - C	05	01	05							00	00						
22	A ₂ - C	04	02	04	05						01	01	00					
42	A ₂ - C	04	02	04	05						01	01	00					
77	A ₂ - C	04	02	04	05						01	01	00					
87	A ₂ - C	05	01	05							00	00						
04	A ₂ - D	03	05	03	03	03	04	05			08	03	03	01	01	00		
36	A ₂ - D	00	06	00	02	04	03	04	05		33	22	07	01	02	01	00	
49	A ₂ - D	00	05	00	04	04	04	05			17	14	01	01	01	00		
74	A ₂ - D	02	05	02	02	04	04	05			11	04	05	01	01	00		
96	A ₂ - D	00	04	00	03	02	05				23	14	04	05	00			

GROUP B₁

S's NO.	CONDITION	DATA RECALL	NO. T	NO. CORRECT PER TRIAL							NO. E	NO. OF ERRORS PER TRIAL							
				1	2	3	4	5	6	7		1	2	3	4	5	6	7	
10	B ₁ - A	04	02	04	05						01	01	00						
38	B ₁ - A	03	02	03	05						02	02	00						
52	B ₁ - A	03	03	03	03	05					07	03	04	00					
65	B ₁ - A	05	01	05							00	00							
90	B ₁ - A	04	02	04	05						01	01	00						
13	B ₁ - B	05	01	05							00	00							
24	B ₁ - B	04	02	04	05						01	01	00						
43	B ₁ - B	04	02	04	05						01	01	00						
66	B ₁ - B	05	01	05							00	00							
98	B ₁ - B	03	02	03	05						03	03	00						
03	B ₁ - C	00	04	00	01	02	05				33	21	08	04	00				
33	B ₁ - C	00	04	00	02	04	05				14	10	03	01	00				
59	B ₁ - C	00	04	00	03	03	05				12	08	02	02	00				
76	B ₁ - C	00	02	00	05						07	07	00						
95	B ₁ - C	00	07	00	01	02	03	01	04	05	38	14	05	08	03	07	01	00	
16	B ₁ - D	00	05	00	01	03	04	05			22	10	09	02	01	00			
30	B ₁ - D	00	03	00	03	05					27	23	04	00					
47	B ₁ - D	00	04	00	02	03	05				28	12	08	02	00				
75	B ₁ - D	00	05	00	03	03	04	05			17	11	02	02	02	00			
81	B ₁ - D	01	04	01	04	03	05				16	12	01	03	00				

GROUP B₂

S's NO.	CONDITIONS	DATA RECALL	NO. T	NO. CORRECT PER TRIAL							NO. E	NO. OF ERRORS PER TRIAL						
				1	2	3	4	5	6	7		1	2	3	4	5	6	7
09	B ₂ - A	04	03	04	04	05					02	01	01	00				
37	B ₂ - A	05	01	05							00	00						
46	B ₂ - A	03	02	03	05						02	02	00					
72	B ₂ - A	03	03	03	04	05					04	03	01	00				
88	B ₂ - A	05	01	05							00	00						
05	B ₂ - B	03	02	03	05						03	03	00					
35	B ₂ - B	04	02	04	05						01	01	00					
60	B ₂ - B	04	03	04	04	05					02	01	01	00				
64	B ₂ - B	04	02	04	05						02	02	00					
82	B ₂ - B	04	03	04	04	05					03	02	01	00				
11	B ₂ - C	05	01	05							00	00						
23	B ₂ - C	00	05	00	03	01	04	05			22	12	03	06	01	00		
45	B ₂ - C	00	04	00	03	04	05				13	10	02	01	00			
79	B ₂ - C	00	03	00	03	05					14	11	03	00				
99	B ₂ - C	01	04	01	04	04	05				10	08	01	01	00			
19	B ₂ - D	01	06	01	03	03	04	02	05		17	07	02	03	01	04	00	
27	B ₂ - D	00	04	00	03	04	05				27	20	05	02	00			
53	B ₂ - D	01	04	01	04	04	05				06	04	01	01	00			
68	B ₂ - D	01	04	01	03	04	05				14	08	04	02	00			
92	B ₂ - D	00	05	00	04	04	04	05			17	13	02	01	01	00		

APPENDIX 6

RESULTS OF NEWMAN-KEULS

Appendix 6 presents the results of the Newman-Keuls for the following:

LEARNING:

- 6.1 - Newman-Keuls on Trials to Criterion in Learning.
- 6.2 - Newman-Keuls on Number Correct per Trial in Learning.
- 6.3 - Newman-Keuls on Number of Errors per Trial in Learning.

RETENTION:

- 6.4 - Newman-Keuls on Data Recall According to Learning Variable.
- 6.5 - Newman-Keuls on Data Recall According to Retention Variable.
- 6.6 - Newman-Keuls on Data Recall Among Level C of Retention According to Learning Variable.
- 6.7 - Newman-Keuls on Trials to Criterion in Relearning According to Learning Variable.
- 6.8 - Newman-Keuls on Trials to Criterion in Relearning According to Retention Variable.
- 6.9 - Newman-Keuls on Trials to Criterion in Relearning According to Retention Variable.
- 6.10 - Newman-Keuls on Number Correct per Trial in Relearning According to Retention Variable.
- 6.11 - Newman-Keuls on Number Correct per Trial in Relearning Among Level C of Retention According to Learning Variable.

- 6.12 - Newman-Keuls on Number of Errors per Trial
in Relearning According to Learning Variable.
- 6.13 - Newman-Keuls on Number of Errors per Trial
in Relearning according to Retention Variable.
- 6.14 - Newman-Keuls on Number of Errors per Trial
in Relearning Among Level C of Retention
According to Learning Variable.

6.1 - Newman-Keuls on Trials to Criterion in Learning.

		A ₁	A ₂	B ₁	B ₂	C
		5.4	5.9	6.1	6.5	9.2
A ₁	5.4	-	0.5	0.7	1.1	3.8***
A ₂	5.9		-	0.2	0.6	3.3***
B ₁	6.1			-	0.4	3.1***
B ₂	6.5				-	2.9***
C	9.2					-

*** P < .01

6.2 - Newman-Keuls on Number Correct per Trial
in Learning.

		C	B ₁	B ₂	A ₁	A ₂
		66.15	83.50	84.15	88.05	88.70
C	66.15	-	17.35***	18.00***	21.90***	22.55***
B ₁	83.50		-	0.65	4.55	5.20
B ₂	84.15			-	3.90	4.55
A ₁	88.05				-	0.65
A ₂	88.70					-

*** P < .01

6.3 - Newman-Keuls on Number of Errors per Trial
in Learning.

		C	B ₁	B ₂	A ₁	A ₂
		0.7380	0.9219	0.9349	0.9789	0.9853
C	0.7380	-	0.1839*	0.1969*	0.2409*	0.2473*
B ₁	0.9219		-	0.0130	0.0570	0.0634
B ₂	0.9349			-	0.0440	0.0504
A ₁	0.9789				-	0.0064
A ₂	0.9853					-

* P < .05

6.4 - Newman-Keuls on Data Recall According to Learning Variable.

		B ₁	B ₂	A ₁	A ₂	C
		35.75	42.80	56.70	59.20	72.60
B ₁	35.75	-	7.05	20.95*	23.45*	36.85*
B ₂	42.80		-	13.90*	16.40*	29.80*
A ₁	56.70			-	2.50	15.90*
A ₂	59.20				-	13.40*
C	72.60					-

* P < .05

6.5 - Newman-Keuls on Data Recall According to Retention Variable.

	D	C	B	A	Control	
	10.65	44.10	67.42	72.45	72.60	
D	10.65	-	33.45***	56.77***	61.80***	61.95***
C	44.10		-	23.32***	28.35***	28.50***
B	67.42			-	5.03	5.18
A	72.45				--	0.15
Control	72.60					--

*** P < .01

6.6 - Newman-Keuls on Data Recall Among Level C
of Retention According to Learning Variable.

		B ₁ -C	B ₂ -C	Control	A ₂ -C	A ₁ -C
		1.0	24.0	72.6	74.4	77.0
B ₁ -C	1.0	-	23.0*	71.6***	73.4***	76.0***
B ₂ -C	24.0		-	48.6***	50.4***	53.0***
Control	72.6			-	1.8	4.4
A ₂ -C	74.4				-	2.6
A ₁ -C	77.0					-

* P < .05

*** P < .01

6.7 - Newman-Keuls on Trials to Criterion in
Relearning According to Learning Variable.

	Control	A ₁	A ₂	B ₁	B ₂
	1.7	2.4	2.6	3.0	3.1
Control	1.7	-	0.7*	0.9***	1.3***
A ₁	2.4	-	0.2	0.6	0.7
A ₂	2.6		-	0.4	0.5
B ₁	3.0			-	0.1
B ₂	3.1				-

* P < .05

*** P < .01

6.8 - Newman-Keuls on Trials to Criterion in
Relearning According to Retention Variable.

	Control	A	B	C	D
	1.70	1.85	2.00	2.65	4.60
Control 1.70	-	0.15	0.30	0.95***	2.90***
A 1.85		-	0.15	0.80*	2.75***
B 2.00			-	0.65*	2.60***
C 2.65				-	1.95***
D 4.60					-

* P < .05

*** P < .01

6.9 - Newman-Deuls on Number Correct per Trial in
Relearning According to Learning Variable.

	B ₁	B ₂	A ₂	A ₁	Control
	73.95	77.10	80.35	80.45	90.00
B ₁ 73.95	-	3.15	6.40	6.50	16.05***
B ₂ 77.10		-	3.25	3.35	12.90*
A ₂ 80.35			-	0.10	9.65
A ₁ 80.45				-	9.55
Control 90.00					-

* P < .05

*** P < .01

6.10 - Newman-Keuls on Number Correct per Trial
in Relearning according to Retention Variable.

	D	C	A	B	Control
	57.15	76.00	88.70	90.00	90.00
D 57.15	-	18.85***	31.55***	32.85***	32.85***
C 76.00		-	12.70***	14.00*	14.00*
A 88.70			-	1.30	1.30
B 90.00				-	0.00
Control 90.00					-

* P < .05

*** P < .01

6.11 - Newman-Keuls on Number Correct per Trial in Relearning among Level C of Retention according to Learning Variable.

	B ₁ -C	B ₂ -C	A ₁ -C	A ₂ -C	Control
	57.0	67.0	90.0	90.0	90.0
B ₁ -C 57.0	-	10.0	33.0***	33.0***	33.0***
B ₂ -C 67.0		-	23.0*	23.0*	23.0*
A ₁ -C 90.0			-	0.0	0.0
A ₂ -C 90.0				-	0.0
Control 90.0					-

* P < .05

*** P < .01

6.12 - Newman-Keuls on Number of Errors per Trial
in Relearning according to Learning Variable.

	B ₁	B ₂	A ₂	A ₁	Control	
	0.6860	0.7061	0.8007	0.8027	0.9204	
B ₁	0.6860	-	0.0201	0.1147*	0.1167*	0.2344*
B ₂	0.7061	-	0.0946*	0.0966*	0.2143*	
A ₂	0.8007		-	0.0020	0.1197*	
A ₁	0.8027			-	0.1177*	
Control	0.9204				-	

* P < .05

6.13 - Newman-Keuls on Number of Errors per Trial
in Relearning According to Retention
Variable.

	D	C	B	A	Control
	0.4700	0.7400	0.8850	0.8920	0.9200
D 0.4700	-	0.2770*	0.4150*	0.4220*	0.4500*
C 0.7400		-	0.1380*	0.1450*	0.1730*
B 0.8850			-	0.0070	0.0350
A 0.8920				-	0.0280
Control 0.9200					-

* $P < .05$

6.14 - Newman-Keuls on Number of Errors per Trial
in Relearning among Level C of Retention
According to Learning Variable.

	B ₁ -C	B ₂ -C	Control	A ₂ -C	A ₁ -C
	0.4895	0.6184	0.9204	0.9414	0.9436
B ₁ -C	0.4895	-	0.1289	0.4309*	0.4519*
B ₂ -C	0.6184	-	0.3020*	0.3230*	0.3252*
Control	0.9204		-	0.0210	0.0232
A ₂ -C	0.9414			-	0.0022
A ₁ -C	0.9436				-

* P < .05

APPENDIX 7

ABSTRACT OF

The Effects of Congruent and Incongruent Contextual Cues on the Learning and Retention of Paired-Associates

A list of paired-associates (random shapes - nonsense syllables) were learned by S's under five (5) conditions with contextual cues consisting of names of colors and ink colors. Four experimental conditions contained two factors at two levels: high meaningfulness - low meaningfulness - congruency - incongruency. A fifth group, the control, learned the list without contextual cues. Retention and relearning were measured 24 hours later under four conditions: (1) similar context, (2) color context, (3) word context, (4) no context. The control was tested in its original no context condition.

Results of the experiment indicated that contextual cues enhanced learning with congruent cues being more facilitating than incongruent cues. Recall of response items was greatest when cues available during learning were still available during retention. Removal of one congruent cue (word or color) had no detrimental effect while for incongruent cues removal of word led to a significant decrement. In all cases, the elimination of both contextual cues was detrimental to performance. For congruent cues

either word and/or color served as functional stimulus; for incongruent cues word only was selected. According to the learning variable, relearning was best for no context, congruent context ranked second, while incongruent context gave the poorest performance. According to the retention variable, detriment occurred only for cases in which a no context was tested or removal of word cue for incongruent conditions was tested.

It was concluded that a subjective or weighted model of stimulus selection may be applied as a consequence of the nature and relative strengths of cues utilized. Educational implications were discussed and possible research proposed.