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The Function of the Postfeedback Interval in Concept Attainment

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THE FUNCTION OF THE POSTFEEDBACK INTERVAL IN CONCEPT ATTAINMENT

By

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LIFE

John M. Paolella was born in Chicago, Illinois on April 6, 1942.

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CHAPTER I

INTRODUCTION

Current research dealing with the role of the postfeedback interval in concept attainment has its historical origin in earlier studies which investigated the function of distribution of practice in the acquisition of concepts. As Bourne (1966) indicates, the length of the postfeedback interval can be conceived of as a condition of practice distribution. With the publication of Underwood's (1952) article on response contiguity, research dealing with distribution of practice and memory effects operative during concept attainment was initiated. Utilizing associationistic theory, Underwood hypothesized that massed practice should be superior to distributed practice on a concept formation task since it would increase the probability of appropriate responses being contiguous.

Oseas and Underwood (1952) compared massed to distributed practice on a concept formation task employing geometric forms exemplifying three-attribute, three-value concepts as stimuli.

Two attributes were relevant to solving the problem and one was irrelevant. The stimulus universe was exposed twice to the subjects, thus yielding a total of 54 figures. A trial was defined as the exposure of 9 figures, with each subject receiving 6 trials. The subject's task was to learn appropriate single-letter responses to the concepts. Stimuli were presented by means of a memory drum at a 3:3 second rate (3 seconds for the stimulus and 3 seconds for the stimulus and response together). Learning was by the anticipation method. The subjects were carefully instructed on the differences between rote learning and concept learning, and were told to use the concept learning approach to solving the task. The independent variable was the length of the intertrial interval which was 6, 15, 30, or 60 seconds. During these intertrial intervals, subjects were required to name colors from a color board. Using trials to the criterion of one perfect recitation as the dependent variable, the 15, 30, and 60 second groups all performed better than the 6 second group but did not differ among themselves. The authors concluded that massed practice inhibited performance. These results failed to support Underwood's hypothesis.

Brown and Archer (1956) conducted a study using geometric forms to compose five basic problems, a problem being defined as four combinations of two bi-level dimensions. These dimensions were relevant to solving the problem. Task complexity was manipulated by introducing 0, 2, 4, or 6 bits of irrelevant information. There were 256 instances in the universe. Instances were presented in 16 trials composed of 16 patterns each. Intertrial intervals of 0, 30, and 60 seconds were introduced. During distributed practice (30 and 60 second intervals), subjects named the suits and denominations of playing cards. The stimuli were presented successively by means of a projector and subjects responded by pressing buttons to identify the category to which the pattern belonged. Accuracy rather than speed was stressed by the instructions. The task was S-paced, with the subject controlling the length of stimulus exposure. The dependent variables were the number of correct responses, errors, and time per trial. Results showed no main effect due to the intertrial interval, but there was a significant Trials X Rests interaction indicating that distributed practice was facilitative at a later stage in learning. Since each subject had only 16 trials, the authors felt that this facilitation due to distributed practice would have been more pronounced if more trials had been given.

Underwood (1957) ran two studies to test the effect of massed and distributed practice on a concept learning task which employed verbal stimuli rather than geometric forms. Three lists of concepts were constructed, each list exemplifying four concepts. There were four examples of each concept, which resulted in each list containing sixteen words. The words used were nouns eliciting common sense impressions. The three lists differed only in the degree of intralist similarity (degree of overlap for descriptive characteristics of different concepts). Stimuli were presented by means of a memory drum. The subject made a hypothesis about the concept during each presentation, followed by E informing him of the correctness or incorrectness of his hypothesis. Subjects received intertrial intervals of 4 or 30 seconds. Groups were compared on 10 learning trials, using the number of correct responses as the dependent variable. No significant main effect was found although the trends were in the direction of distributed practice.

It is difficult to interpret the effects of the intertrial interval in the preceding experiments of Oseas and Underwood, and Brown and Archer. The tasks utilized in these studies introduced a rote learning component which contributed to a very substantial portion of the total score. Richardson and Bergum (1954) have demonstrated that the rote learning component tends to obscure the actual process of concept learning. Dominowski (1965) in his review of memory effects operative in concept formation has pointed out that as the rote learning component of a task increases, distributed practice is more likely to have a facilitative effect. Also, as the number of total trials increases, the rote learning component contributes more to the total score making it appear that distributed practice has a facilitative effect. In view of these findings and critiques one cannot be certain if increases in the intertrial interval facilitated concept learning *per se* as reported in the studies of Oseas and Underwood, and Brown and Archer, or facilitated the rote learning task which was the indirect measure of concept attainment. Another problem which confounds the issue in both of these studies is that spaced intervals were filled with such unrelated tasks as color naming. It would seem that these tasks should have caused some interference in concept attainment, yet this was not the case. This would further suggest that the spacing had its positive effect on the rote learning component of the task rather than on the concept learning component.

Another factor which is relevant to the discussion of practice distribution in concept attainment is that of stimulus sequence effects. In evaluating the effect of the intertrial interval in studies which utilize a reception paradigm, one must consider the inter-relationship among the stimuli presented to the subject by E. In the following studies which investigated stimulus sequence effects, one should note that the intertrial interval is not conceived of as a "rest period" or "time out" introduced between the presentation of stimuli, but rather a "time out" in which instances of "other" concepts are presented to a subject. Underwood (1952) hypothesized that greater temporal contiguity among representations of the same concept will lead to faster learning of that concept. The closer in time instances of the given concept occur, the more rapid will be the concept attainment. Newman (1956) tested this prediction using a paired-associates procedure where subjects had to give an appropriate letter response to a class of geometric figures. He used four-attribute concepts with two dimensions relevant and two irrelevant. Nine different concepts were to be learned, with nine instances of each concept exposed to the subjects. A trial was defined as the presentation of nine instances. Each subject received nine trials. The "Low Contiguity" condition was manipulated by presenting one instance of each concept per trial. With "High Contiguity," six of the instances of a concept were presented in close proximity, the average separation between them being 4.55 instances of "other" concepts. Each subject attempted to learn under various contiguity conditions. The dependent variables were number of concepts learned and number of errors. Results were significant in favor of the "High Contiguity" condition in which concept instances had greater temporal contiguity. Since a repeated measures design was utilized, the possibility of "learning effects" may have contributed to the results.

Kurtz and Hovland (1956) compared contiguity effects in a situation where each subject was presented with only a single contiguity condition. The stimuli used were geometric forms varying on five two-valued dimensions. There were four instances of each of eight concepts. Subjects had to learn the appropriate letter response to stimuli. There were two methods of presentation: for one group, all four instances of a single concept were presented in succession (unmixed presentation); for the other group (mixed presentation), two instances of one concept were always separated by one or more instances of another concept. Performance was measured by the number of correct identifications, and by means of a verbal descriptions test in which

S was required to give common stimulus properties to the nonsense syllable defining the concept. Results were significant in favor of the group receiving the unmixed condition, on the verbal descriptions test. In reviewing this study Bourne (1966) states that the most likely interpretation of the findings is based on memory interference resulting from the interpolation of instances of irrelevant concepts between examples of any one given concept. He maintains that a subject must retain sufficient information from positive instances of a given concept in order to abstract their relevant or defining characteristics. In the unmixed presentation of high contiguity condition, these memory requirements are minimized thereby facilitating concept attainment.

Peterson (1962) varied contiguity between groups by using as stimuli geometric figures having a variable number of three-valued dimensions. The independent variables were the percentage that various dimensions were relevant, and the method of presentation. In Homogeneous Presentation, three instances of the same concept were repeatedly shown until the subjects made the correct response three times consecutively by pressing keys. In Heterogeneous Presentation, each set of three instances contained one instance of each of the three concepts to be learned. The dependent variables were trials to criterion and number of correctly identified dimensions. On both of these measures, Homogeneous presentation was significantly superior. Peterson interpreted her results in the following manner: the superiority of Homogeneous Presentation may have resulted from the closer proximity of instances of a given concept, or another possibility is that the absence of interference from presentation of instances of other concepts permitted faster learning. Peterson ran a second experiment to investigate these alternatives. The problems were presented using the homogeneous sequence while preserving the exact temporal ordering of the instances in the related heterogeneous condition of the previous experiment. The intervals were filled with a digit cancellation task for one group and left unfilled for another. The control subjects learned the problems using the homogeneous condition of the previous experiment. Using the same measures of performance as in the first experiment, Peterson found significant differences only for the most difficult problems, and for the unfilled-filled intervals. She concluded that it was not the massed practice effect that made the homogeneous condition superior to the heterogeneous condition in the first experiment, but that the interference effect (from the introduction of instances of other concepts or the digit cancellation) impaired concept attainment in the heterogeneous condition.

Bourne and Jennings (1963) investigated stimulus sequence effects by manipulating four degrees of instance contiguity. The task presented to the subjects involved the assignment of numerals to various combinations of an upper and lower case letter. Simuli were presented successively and after each presentation the subject received feedback as to the correctness or incorrectness of his response. The task was S-paced in that the subject determined the length of stimulus exposure. Contiguity was defined in terms of the conditional probability that another instance of the same concept would immediately follow was 8/32, 14/32, 20/32, or 26/32 for the various groups. The dependent variable was the number of incorrect responses in 256 trials. Results showed that performance improved linearly with increased contiguity. In reviewing this study, Dominowski (1965) states that since the rate of presentation was subject paced and therefore variable, the results support the hypothesis that interference due to interpolated instances of other concepts is more important than the temporal factor *per se*.

A different approach to investigating the role of temporal factors in concept attainment other than "practice distribution" and "stimulus sequence effects" has been taken by Bourne and his associates. In comparing Bourne's research design to that of the studies previously cited dealing with distribution of practice, one must distinguish between a postfeedback interval and an intertrial interval. Earlier studies utilizing an intertrial interval allowed the subject a rest period after every *n*th number of stimuli, or trial block was presented. In Bourne's studies he utilizes a postfeedback interval which allows the subject a rest period after each stimulus is presented. Bourne (1966) maintains that the use of a postfeedback interval minimizes memory effects whereas the intertrial interval does not. He hypothesizes that if during the rest period a subject does indeed utilize relevant information in arriving at a solution to the problem, the probability of forgetting significant bits of information is lessened when a postfeedback interval is used rather than an intertrial interval. The fewer the number of stimuli (or trials) between rest periods, the less the chance of forgetting significant information.

The research of Bourne and his associates follows this same general procedure: (a) By means of a stripfilm projector, geometric patterns are presented one at a time to the subject; (b) The subject's categorizing response to the stimulus is made by pressing one of a number of available keys; (c) The immediate withdrawl of the stimulus and presentation of informative feedback that signals the correct response; (d) A brief postfeedback interval which is unfilled is introduced. Utilizing this experimental design Bourne and Bunderson (1963) used a 3 X 3 X 2 factorial design with three lengths of postfeedback interval (1, 5, and 9 seconds), and two degrees of task complexity (1 and 5 irrelevant stimulus dimensions). Using number of errors as the dependent variable, results indicated that performance improved linearly with increases in the postfeedback interval, and that increases in this interval were more facilitative in tasks of greater complexity. The authors interpreted their results as suggesting that concept learning does not take place immediately and automatically as a function of informative feedback *per se*. If this were the case, length of the postfeedback interval should have no unique effect on performance. Rather the authors maintained that the data indicate that subjects used the postfeedback interval to memorize, rehearse, or otherwise process the information they had been given by the stimulus and its accompanying feedback.

Bourne, Guy, Dodd, and Justesen (1965) extended the previous study by combining four lengths of postfeedback interval (1, 9, 17, and 25 seconds), and the same two degrees of task complexity as in the previous study. They found that performance improved then became worse with increases in the interval, the optimal length being greater in more complex problems. The authors interpreted this observed optimizing and subsequent deterioration of performance under longer postfeedback intervals as suggesting an interference effect that accumulated during and across the intervals, eventually overcoming the gains due to moderate postfeedback interval durations. Bourne et al. attributed this interference to loss of memory for information provided by previously displayed instances of the concept. They found that performance did not deteriorate, even with the longest postfeedback interval used, when they modified their procedure and allowed stimulus patterns to remain available to the subject during the postfeedback interval.

Bourne et al. (1965) also demonstrated that use of an _S_-paced stimulus interval in place of the usual _E_-paced stimulus interval did not alter the effect produced by the postfeedback interval. Subjects did not seem to compensate for short postfeedback intervals by lengthening the stimulus interval.

In reviewing Bourne's studies, Pikas (1966) states that the postfeedback facilitation effect in concept learning is conceptually similar to the effect of "maturity" or "settlement" in learning which has been demonstrated on other laboratory tasks. Using mediational theory, Pikas hypothesizes that during the optimal postfeedback interval the organism is able to "code" and "recode" stimulus information to its best advantage, and thereby more quickly arrive at a solution to the problem.

The facilitative effect of the postfeedback interval has been clearly demonstrated in the previously cited research of Bourne et al. (1963, 1965) in which a reception paradigm was utilized. There are several characteristics of this paradigm which should be noted. First, instances of the stimuli are presented one at a time or successively to S. Second, the S responds to a stimulus instance by placing it into one of a number of available categories provided by E. Third, E determines which instances of the stimuli will be presented to S. An alternative methodological approach to investigating concept attainment is the selection paradigm, as exemplified by the work of Bruner, Goodnow, and Austin (1956). With this method the entire stimulus universe is presented in full or simultaneously to S, and on the basis of this the S selects stimulus instances which he feels are relevant to the solution of the problem. Characteristic of the selection paradigm then, is simultaneous presentation of stimuli, and the allowance of S to choose stimulus instances to which he will respond.

In regard to the first difference between these two paradigms, that is, type of stimulus presentation, Bourne, Goldstein, and Link (1964) have demonstrated that these two types of stimulus presentation are not dichotomous, but rather endpoints on a continuum of stimulus availability. If this is the case, one would expect that the facilitative effect of the postfeedback interval as demonstrated in the Bourne studies utilizing successive presentation, would also be operative under the condition of simultaneous presentation of stimuli. In order to test this interpretation, the present study introduced three lengths of postfeedback interval (0, 15, and 30 seconds), into a concept attainment task utilizing the Bruner method of simultaneous presentation of stimuli. There were two degrees of task complexity (2 and 4 attribute concepts). Using "number of card choices to solution", and the error scores of "number of untenable hypotheses" and "percentage of untenable hypotheses" as the dependent variables, it was hypothesized that increases in the postfeedback interval would facilitate concept attainment.

The selection paradigm which was employed in the present study also provides additional measures of performance which the reception paradigm does not. Because it allows a subject to choose his own stimulus instances, the selection paradigm provides E with information about the strategy being used by S to solve a problem. Bruner et al. (1956) have distinguished two basic selection strategies of focusing and scanning in concept attainment. In focusing, S tests the relevance of all the possible hypotheses involved in a particular attribute or attributes by choosing a card differing in one (conservative focusing) or more (focus gambling) attributes from a positive focus card. In scanning, S tests specific hypotheses, either singly (successive scanning) or all at once (simultaneous scanning) or in some intermediate number. In general, focusing is a more successful strategy in terms of minimizing card choices to solution, which Bruner et al. (1956) interpret as due to the more difficult memory requirements of scanning. Laughlin (1966) found that four attribute concepts resulted in more use of focusing strategy than two attribute concepts, with no difference in the use of scanning strategy. In the present study it was hypothesized that this finding would be replicated.

In addition to investigating the function of the postfeedback interval in concept attainment, the present study explored the relationship between a subject's perceptual style and his performance on concept attainment problems. Research by Witkin (1951, 1954), and Witkin et al. (1962) has demonstrated two perceptual styles, field-independence and field-dependence. The field-independent style is an analytical, active mode of dealing with the perceptual field whereas the field-dependent style represents a global, passive mode of operation. Witkin has established that these perceptual styles are operative in a variety of both perceptual and intellectual activities. One of the tests used to measure perceptual style is the Embedded Figures Test which requires S to separate an item from an embedding context of a field. The validity of the Embedded Figures as a measure of

S's ability to overcome the effects of an embedding context has been demonstrated by Witkin (1951, 1954), Witkin et al. (1962), and Karp (1963). The reliability of the test has been established in studies by Bauman (1951), Linton (1952), Longenecker (1956), Gardner et al. (1960), and Witkin et al. (1962).

One of the factors contributing to successful performance on the type of concept attainment problem employed in the present study seemed to involve the use of an analytical perceptual style. This field-independent style might be manifested by S's ability to initially separate the stimulus dimensions of the concept attainment display, and maintain this separation throughout the task. Using "number of card choices to solution", "number of untenable hypotheses", and "percentage of untenable hypotheses" as the dependent measures of conceptual performance, it was hypothesized that there would be a significant relationship between the "field-independent" perceptual style (as measured by the Witkin Embedded Figures Test), and S's performance on the concept attainment problems.

In summary, it was the primary purpose of this present study to investigate the function of the postfeedback interval in a concept attainment problem utilizing a selection paradigm in which stimuli were presented simultaneously to S. It was the secondary purpose of this research to investigate the relationship between a subject's perceptual style, as measured by Witkin's Embedded Figures Test, and his ability to solve concept attainment problems.

CHAPTER II

METHOD

Design and subjects.-- A 2 X 3 X 3 repeated measures factorial design was used with the variables: (a) number of relevant problem attributes (two or four); (b) length of post-feedback interval (0, 15, or 30 seconds); (c) problems (three per subject). Six male and six female college students were randomly assigned to each of the six conditions.

Stimulus displays and problems.-- An ektachrome slide of a geometric form display was used as the stimulus. The original display board which was photographed was a 28" by 44" white posterboard, containing an 8 X 8 array of 64, 2½" by 4" cards drawn in colored ink with dark outlines. The 64 cards represented all possible combinations of six attributes with two levels of each. The form display consisted of the following attributes and values: (1) shape: square or triangle, (2) size: large or small, (3) number: one or two, (4) color: red or green, (5) pattern: striped or solid, and (6) borders: one or two.

The slide made of this display was a clear reproduction which retained all the formal detail and color of the original board. The slide image was projected to a size of approximately 10" by 14".

The attributes and values were listed on a reference card which S could use throughout the experiment.

Each problem and initial focus card for each S were randomly selected from the total subset of possible two-attribute and four-attribute problems. All Ss were given one practice and three test problems.

Procedure.-- The usual Bruner-type presentation was altered to allow for the introduction of a postfeedback interval in four of the experimental conditions (the two remaining conditions received no postfeedback interval and remained unaffected). In these four conditions the temporal factor was introduced in the following way: After S had chosen an instance and either (a) made a hypothesis about the concept and was informed of the correctness or incorrectness by E, or (b) in the case where S did not make a hypothesis and informed E of this fact, the stimulus board (slide) was removed for the appropriate length of time and reappeared after the postfeedback interval had elapsed. Removal of the board was controlled by E who covered the lens of the slide projector with an opaque disc for the alotted period of time. E used a stopwatch to time the length of the postfeedback interval. The postfeedback interval was therefore defined as the length of time ranging from E's informative feedback (followed by the removal of the stimulus), to the time when the stimulus board (slide) was revealed to S for the next trial. The task still remained subject paced in that S determined the length of time the stimulus was exposed before making a hypothesis. The only temporal factor controlled by E was the length of the postfeedback interval.

The subjects in all conditions received the following instructions:

"You see before you 64 cards with various figures on them. The cards vary in the shape of the figure on them, the size of the figure, the number of figures, the color of the figure, the pattern of the figure, and the number of borders surrounding the cards. These six qualities of the stimuli, that is, the shape, size, number, color, pattern and number of borders are called attributes. Each attribute has two values (S is given the reference card and E illustrates by pointing to examples on the board). The attribute of size has two values large or small, the attribute of number of figures has two values one or two, the attribute of color has two values red or green, the attribute of pattern has two values striped or solid, and the attribute number of borders has two values one or two.

We are interested in grouping these cards on the basis of a certain number of attribute values they share in common. This basis for grouping, or the principle by which we group the cards is called a concept. The type of concepts we will be dealing with are called conjunctive concepts. A conjunctive concept is illustrated by a set of cards which share a certain number of values in common. We will be grouping the cards on the basis of 2 (or 4) values they share in common. (E gives two examples of a 2 (or 4) value concept and then asks S to point out all the exemplars of a 2 (or 4) value concept).

What we will be doing in the remaining portion of this experiment is basically the same type of grouping problem. I'll have a concept in mind that certain cards before you will illustrate and others will not, however, this time it will be your task to determine what the concept is that I'm thinking of. You will go about this in the following way. I'll begin by pointing to a card which is included in the concept, that is, one of the group of cards which exemplifies the concept I have in mind. You will then select any card you wish (by pointing to it with the pointer) that you feel will provide you with some information as to what the concept is I'm thinking of. If the card you select is included in the concept I will tell you "yes", and if it is not included in the concept I will tell you "no". Notice, that if you get a "yes" it means that both (or all four) values of the concept are on the card, otherwise you will get a "no". (E gives an example and points out the difference between a complete positive instance, a partial positive instance, and a negative instance). After you receive your "yes" or "no", you will then have the opportunity to make a hypothesis or guess as to what you think the concept is. I will inform you if your guess is correct or not. You can only offer one hypothesis after each card is chosen. If you do not wish to make a hypothesis after certain card choices you don't have to. You will continue this procedure of choosing cards one at a time, me giving you a "yes" or "no" depending on whether the card you select is included in the concept, and then you making a hypothesis if you wish, until you have solved the problem. The problem is solved when you give me a correct hypothesis which tells me what the concept is I'm thinking of.

The amount of time you take to solve the problem is unimportant. Also, if you should make some incorrect hypotheses after card choices this is only of secondary importance. The object is to solve the problem by using as few card choices as possible. This is the most important thing."

In the four conditions where the postfeedback interval was introduced, the following additional instructions were given to Ss. These were given after S's first card choice on the practice problem:

"There is another step in the problem that I should like to introduce at this time. After you have chosen a card and either (a) given a hypothesis, or (b) told me "no hypothesis" if you do not wish to make one, I will remove the display board from the screen (E illustrates) for a certain period of time. After this time period has elapsed the display will reappear (E illustrates) and you will then continue on and select another card for testing. The display will be removed after every card choice. What you are to do during this time period when the board is off the screen, is use the information you have accumulated so far and work on an answer to the problem. In effect what is happening is that you are being given a "time out" between card choices to think about an answer to the problem." (E begins the practice problem once again and introduces the postfeedback interval between card choices).

After each S had completed the concept attainment problems he was administered the Embedded Figures Test. This test developed by Witkin is composed of 24 complex figures (Black and White, and Colored designs), in each of which a simple figure is concealled. A simple figure is shown to S for 15 seconds and then removed. The complex figure is then presented and it is S's task to locate the simple figure within the complex one. A maximum of 5 minutes is allowed per figure. If S forgets what the simple figure looks like, he is allowed to re-examine it while the complex figure has been removed. The following instructions were given to S prior to the task:

"I am going to show you a series of colored designs. Each time I show you one of these designs, I want you to describe the overall pattern that you see in it. After examining each design, I will show you a simpler figure which is contained in that larger design. You will then be given the larger design again, and your job will be to locate the smaller figure in it. Let us go through one to show you how it's done. (S is given a practice problem, and upon locating the figure he is told by E): Would you now trace the figure with this (blunt stylus) without touching the paper.

(S is then told): This is how we will proceed on all trials. I would like to add that in every case the smaller figure will always be present in the larger design. It will always be in the upright position. There may be several of the smaller figures in the same larger design, but you are to look only for the one in the upright position. This means that any reversal of the figure, either a top-bottom or right-left reversal, will be regarded as incorrect. Work as quickly as you possibly can, since I will be timing you, but be sure that the figure you find is exactly the same as the original figure, in size, proportions, and position. As soon as you have found the figure, tell me at once. If you ever forget what the small figure looks like, you may ask to see it again. Are there any questions?"

CHAPTER III

RESULTS

The data for the concept attainment problems were analyzed for the dependent variables card choices to solution, focusing strategy, scanning strategy, number of untenable hypotheses, and percentage of untenable hypotheses. These measures were then correlated with scores from the Embedded Figures Test.

Card choices to solution. The mean card choices to solution for the six groups are given in Table 1, and the results of the analysis of variance for card choices are in Table 2.

Table 1

Mean Card Choices to solution over Three Test Problems

	Two Attributes	Four Attributes	Total
0" Interval	18.83	22.41	41.24
15" Interval	17.50	16.33	33.83
30" Interval	13.33	12.58	25.91
Total	49.66	51.32	

Table 2

Analysis of Variance for Card Choices to Solution

Source	d.f.	MS	F
Attributes (A)	1	1.85	
Interval (I)	2	117.60	6.37*
A X I	2	13.84	
Error (B)	66	18.45	
Problems (P)	2	32.79	2.00
P X A	2	18.98	1.16
P X I	4	14.51	
P X A X I	4	79.51	
Error (W)	132	16.36	

*$p < .005$

The only significant effect for card choices to solution over three test problems was the highly significant one for the postfeedback interval (F (1,66)=6.37, $p < .005$). Since there was no significant difference for number of attributes, Duncan Multiple Range Comparisons were performed between the three postfeedback intervals summing over attributes. Comparisons resulted in a significant difference in performance between the 0" interval group and the 30" interval group ($p < .01$), but not between the 0" and 15" groups, or the 15" and 30" interval groups. (See Appendix 1).

Focusing Strategy. Focusing strategy was scored according to two rules; (Rule 1) Each card choice had to obtain information on one new attribute. New information was obtained if the card choice altered only one attribute not previously proven irrelevant (conservative focusing), or, if more than one attribute was altered (focusing gambling), the instance was either positive or the ambiguous information correctly resolved on the next card by altering only one attribute. (Rule 2) If a hypothesis was made it had to be tenable considering the information available. Untenable hypotheses were of two types: (a) a hypothesis for a value of an attribute when the other value of the attribute had previously occured on a positive instance, e.g., the hypothesis "red square" when a green instance had been positive; (b) a hypothesis which had previously occurred on a negative instance, e.g., the hypothesis "red square" when an instance with a red square had been negative. Each card choice and accompanying hypothesis that satisfied these two rules was counted as an instance of focusing, and the total number of such instances was divided by the total number of card choices to give a continuous focusing score from .00 to 1.00.

The means for the six groups for focusing strategy are given in Table 3, and the results of the analysis of variance for focusing are given in Table 4. The graph for the A X I interaction for focusing strategy is shown in Figure 1.

Table 3

Mean Focusing Strategy over Three Test Problems

	Two Attributes	Four Attributes	Total
0" Interval	1.89	1.90	3.79
15" Interval	1.68	2.02	3.70
30" Interval	2.22	2.12	4.34
Total	5.79	7.04	

Table 4

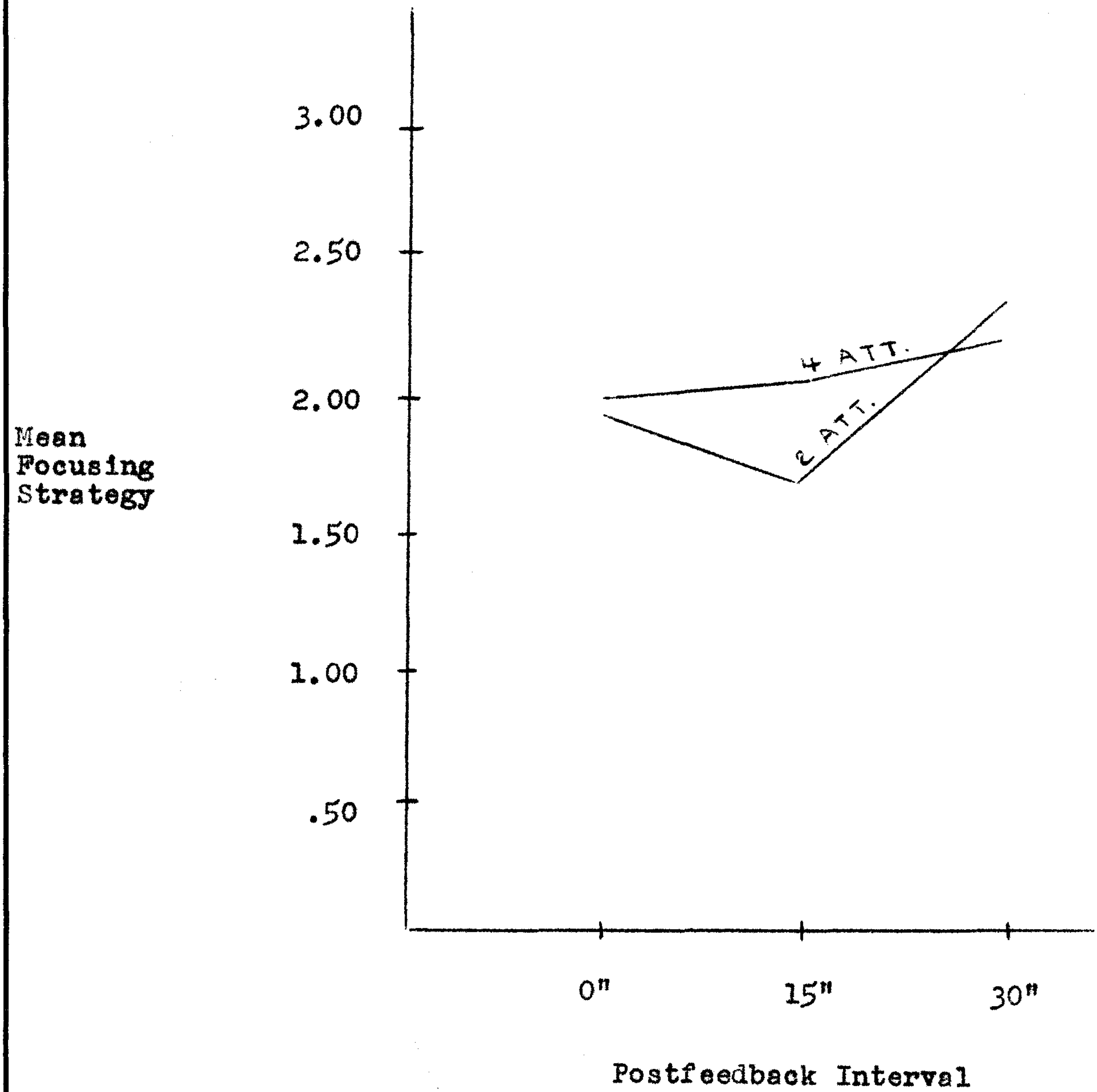
Analysis of Variance for Focusing Strategy

Source	d.f.	MS	F
Attributes (A)	1	.04	
Interval (I)	2	.24	2.00
A X I	2	.36	3.61*
Error (B)	66	.10	
Problems (P)	2	.13	1.57
P X A	2	.13	1.53
P X I	4	.02	
P X A X I	4	.06	
Error (W)	132	.08	

*$p < .05$

Figure 1

A X I Interaction for Focusing Strategy



None of the three main effects of attributes, interval or problems was significant for focusing strategy. The only significant interaction effect was between attributes and interval, ($\underline{F}$ (2,66)=3.61, $\underline{p} < .05$). Duncan Multiple Range Comparisons were performed to test for significant differences between the three postfeedback intervals for two attribute problems, and for four attribute problems. With respect to two attribute problems, the group which received the 30" postfeedback interval used significantly more focusing than the group receiving the 15" interval ($\underline{p} < .05$). However, there were no significant differences in focusing between the 30" interval group and the 0" interval group. (See Appendix 2). For the four attribute problems, there were no significant differences in focusing between the three interval groups. (See Appendix 2).

Duncan Multiple Range Comparisons were also made between two and four attribute problems receiving the same length of postfeedback interval. There was significantly more focusing on the four attribute problems than on two attribute problems for the 15" postfeedback interval ($\underline{p} < .05$). There were no significant differences in focusing between two and four attribute problems for both the 0" interval and the 30" interval. (See Appendix 3).

<u>Scanning strategy.</u> Scanning strategy was scored by comparing each card in turn with the given problem card. If the selected card was positive, all concepts differing on the given and selected cards were eliminated; if the selected card was negative, all concepts identical on the given and selected cards were eliminated.

The total of the number of concepts thue eliminated plus those concepts eliminated by direct hypotheses was then divided by the total number of card choices on the problem in order to give the average number of concepts eliminated per card choice. This measure was considered an index of scanning.

The means for the six groups for scanning strategy are given in Table 5, and the results of the analysis of variance for scanning are given in Table 6.

Table 5

Mean Scanning Strategy over Three Test Problems

	Two Attributes	Four Attributes	Total
0" Interval	31.24	29.39	60.63
15" Interval	32.47	29.15	61.62
30" Interval	34.16	32.08	66.24
Total	97.87	90.62	

Table 6

Analysis of Variance for Scanning Strategy

Source	d.f.	MS	F
Attributes (A)	1	35.01	1.94
Interval (I)	2	17.95	
A X I	2	1.21	
Error (B)	66	18.11	
Problems (P)	2	29.08	1.50
P X A	2	2.97	
P X I	4	12.41	
P X A X I	4	.51	
Error (W)	132	19.39	

None of the three main effects of attributes, interval or problems were significant for scanning strategy. Likewise none of the interactions were significant.

Untenable hypotheses. Untenable hypotheses have previously been defined in conjunction with the scoring for focusing strategy (see above). The means for the six groups for number of untenable hypotheses per problem over three test problems are given in Table 7, and the analysis of variance for this measure is given in Table 8.

Table 7

Mean Number of Untenable Hypotheses over Three Test Problems

	Two Attributes	Four Attributes	Total
0" Interval	6.33	3.58	9.91
15" Interval	5.66	4.91	10.57
30" Interval	3.42	3.25	6.67
Total	15.41	11.74	

Table 8

Analysis of Variance for Untenable Hypotheses

Source	d.f.	MS	F
Attributes (A)	1	7.78	
Interval (I)	2	8.39	1.03
A X I	2	4.24	
Error (B)	66	8.16	
Problems (P)	2	6.68	
P X A	2	17.00	2.26
P X I	4	6.19	
P X A X I	4	12.38	1.65
Error (W)	132	7.50	

None of the main effects of attributes, intervals or problems were significant for untenable hypotheses. Likewise none of the interactions were significant.

Percentage of Untenable Hypotheses. The percentage of untenable hypotheses per problem was computed in the following manner: Number of untenable hypotheses per problem (previously defined) was divided by the total number of card choices for the problem, and then this quotient was multiplied by one hundred.

The means for the six groups for percentage of untenable hypotheses per problem over three test problems are given in Table 9, and the analysis of variance for this measure is given in Table 10.

Table 9

Percentage of Untenable Hypotheses per Problem over Three Test Problems

	Two Attributes	Four Attributes	Total
0" Interval	52.71	37.22	89.93
15" Interval	72.04	58.67	130.71
30" Interval	42.14	41.40	83.54
Total	166.89	137.29	

Table 10

Analysis of Variance for Percentage of Untenable Hypotheses

Source	d.f.	MS	F
Attributes (A)	1	594.77	1.12
Interval (I)	2	1299.83	2.42
A X I	2	122.30	
Error (B)	66	536.52	
Problems (P)	2	37.34	
P X A	2	234.76	
P X I	4	40.81	
P X A X I	4	531.93	1.21
Error (W)	132	440.86	

None of the main effects of attributes, interval or problems were significant, or were any of the interactions for percentage of untenable hypotheses. However, there was a trend toward significance for the effect of the interval ($\underline{F}$ (2,66)=2.42, $\underline{p} < .10$). Duncan Multiple Range Comparisons were performed between the three intervals summing over attributes. There was a significant difference in performance between the 30" interval group and the 15" interval group ($\underline{p} < .05$), but not between the 30" and 0" groups, or the 15" and 0" groups. (See Appendix 1).

Table 11

Intercorrelations of Response Measures, All Intervals (d.f.=71)

	CC	Focusing	Scanning	#UH
Focusing	-.753**			
Scanning	-.246*	.154		
#UH	.776**	-.725**	-.076	
%UH	.568**	-.769**	-.066	.825**

*$\underline{p} < .05$
**$\underline{p} < .01$

Note: Throughout Tables 11-14 the following abbreviations are used: CC - Card Choices, #UH - Number of untenable hypotheses, %UH - Percentage of untenable hypotheses.

Table 12

Intercorrelations of Response Measures, 0" Interval (d.f.=23)

	CC	Focusing	Scanning	#UH
Focusing	-.852*			
Scanning	-.379	.192		
#UH	.802*	-.729*	-.127	
%UH	.718*	-.821*	-.161	.883*

*p < .01

Table 13

Intercorrelations of Response Measures, 15" Interval (d.f.=23)

	CC	Focusing	Scanning	#UH
Focusing	-.608*			
Scanning	.028	-.119		
#UH	.793*	-.608*	.178	
%UH	.607*	-.636*	.175	.874*

*p < .01

Table 14

Intercorrelations of Response Measures, 30" Interval (d.f.=23)

	CC	Focusing	Scanning	#UH
Focusing	-.723*			
Scanning	-.061	.232		
#UH	.802*	-.836*	-.126	
%UH	.552*	-.738*	-.116	.818*

*p <.01

Table 11 shows the intercorrelations between the five response measures across all three of the postfeedback intervals. There was a significant relationship at the .05 level between card choices to solution and scanning strategy (r=-.246). At the .01 level, card choices to solution correlated significantly with focusing strategy (r=-.753), with number of untenable hypotheses (r=.776), and with percentage of untenable hypotheses (r=.568). There was also a significant relationship at the .01 level between focusing strategy and number of untenable hypotheses (r=-.725), focusing strategy and percentage of untenable hypotheses (r=-.769), and number of untenable hypotheses and percentage of untenable hypotheses (r=.825).

Tables 12-14 show the intercorrelations between the five response measures within each of the three postfeedback intervals. For the 0" interval the following measures were significantly related at the .01 level: card choices to solution and focusing strategy (r=-.852), card choices to solution and number of untenable hypotheses (r=.802), card choices to solution and percentage of untenable hypotheses (r=.718), focusing strategy and number of untenable hypotheses (r=-.729), focusing strategy and percentage of untenable hypotheses (r=-.821), number of untenable hypotheses and percentage of untenable hypotheses (r=.883). For the 15" interval the following measures were significantly related at the .01 level: card choices to solution and focusing strategy (r= -.608), card choices to solution and number of untenable hypotheses (r=.793), card choices to solution and percentage of untenable hypotheses (r=.607), focusing strategy and number of untenable hypotheses (r=-.608), focusing strategy and percentage of untenable hypotheses (r=-.636), and number of untenable hypotheses and percentage of untenable hypotheses (r=.874). For the 30" interval the following measures were significantly related at the .01 level: card choices to solution and focusing strategy (r= -.723), card choices to solution and number of untenable hypotheses (r=.802), card choices to solution and percentage of untenable hypotheses (r=.552), focusing strategy and number of untenable hypotheses (r=-.738), number of untenable hypotheses and percentage of untenable hypotheses (r=.818).

Embedded Figures Test (EFT). The Embedded Figures Test score was the mean time (in seconds) it took a subject to discover a simple figure. A high EFT score reflects a field-dependent or global perceptual approach, whereas a low EFT score reflects a field-independent, or analytical perceptual approach. The EFT score for each subject was intercorrelated with the five response measures from the concept attainment task. Table 15 gives the intercorrelations between EFT scores and the five response measures across all three of the postfeedback intervals. Tables 16-18 shows the intercorrelations between EFT scores and the five response measures within each of the postfeedback intervals.

Table 15

Intercorrelations between EFT Scores and Concept Attainment Response Measures, All Intervals (d.f.=71)

	CC	Focusing	Scanning	#UH	%UH
EFT	.174	-.204	-.070	.105	.128

Note: Throughout Tables 15-18 the following abbreviations are used: CC - Card choices, #UH - Number of untenable hypotheses, %UH - Percentage of untenable hypotheses.

Table 16

Intercorrelations between EFT Scores and Concept Attainment Response Measures, 0" Interval (d.f.=23)

	CC	Focusing	Scanning	#UH	%UH
EFT	.182	-.253	-.098	.059	.146

Table 17

Intercorrelations between EFT Scores and Concept Attainment Response Measures, 15" Interval (d.f.=23)

	CC	Focusing	Scanning	#UH	%UH
EFT	.152	-.135	-.119	.196	.157

Table 18

Intercorrelations between EFT Scores and Concept Attainment Response Measures, 30" Interval (d.f.=23)

	CC	Focusing	Scanning	#UH	%UH
EFT	.251	-.201	.077	-.035	-.201

Tables 15-18 show consistently low intercorrelations between EFT scores and the five concept attainment response measures. None of these intercorrelations reached a level of significance.

CHAPTER IV

DISCUSSION

The major results of this study are as follows: (a) Using a selection paradigm there is a significant temporal effect due to the postfeedback interval in a concept attainment task. This effect is significant for the response measures number of card choices to solution, and percentage of untenable hypotheses. (b) No main effects due to either attributes or problems. (c) A significant interaction effect between attributes and interval for the response measure focusing. (d) No significant relationship between Embedded Figures Test scores and any of the five measures of conceptual performance.

While the facilitative effect of the postfeedback interval in concept attainment has been shown in studies by Bourne et al. (1963, 1965) using a reception paradigm, to the author's knowledge this relationship has not been established for a selection paradigm. The results of the present study demonstrate this effect for a research design utilizing a selection paradigm.

The present study is definitely not comparable with earlier studies which investigated the temporal effect in concept formation from the frame of reference of stimulus sequence effects. It was their purpose to investigate the effect of relevant or irrelevant stimulus material introduced during the intertrial interval. In contrast with these studies, it was the purpose of the present study to investigate the function of a "free" or "unfilled" interval in concept attainment. Likewise, it is difficult to compare the results of the present study with earlier studies dealing with practice distribution, ie. Oseas and Underwood (1952), and Brown and Archer (1956). In addition to these earlier investigations employing a reception paradigm, intertrial intervals were introduced only after every _n_th number of stimuli (or trial block) was presented to _S_. In contrast, the present study utilized a selection paradigm and allowed an intertrial (postfeedback) interval after each stimulus was presented to _S_.

It seems that the present investigation most closely approximates the earlier research of Bourne and his associates (1963, 1965), although Bourne employed a reception paradigm and the present study used a selection paradigm. However, the results of both the Bourne studies and the present study demonstrate the facilitative effect produced by the postfeedback interval in concept attainment, although both studies used different dependent measures. Bourne demonstrated the effect using an error score, whereas the present research shows the effect for a positive measure of performance (card choices to solution), and an error measure (percentage of untenable hypotheses). The Bourne studies also established that performance improved linearly with increases in the postfeedback interval and then deteriorated over longer intervals. The present study did not produce this effect. An extension of the present investigation in which a greater range of the postfeedback interval is explored is suggested to test for this effect. In interpreting his results, Bourne suggests that Ss used the postfeedback interval to memorize, rehearse, or otherwise process the information they had been given by the stimulus and its accompanying feedback. From the results of the present study it is difficult to theorize as to the nature of the facilitative effect observed. Since there was no main effect demonstrated for either of the strategies of focusing or scanning, one cannot attribute the effect to the adoption of one specific strategy. For the results of the present study it is suggested that the postfeedback facilitation observed in the 30" interval group might have been due to S's incresed attention and motivation caused by the removal of the stimulus array during the postfeedback interval.

However, this interpretation would have to be investigated via future research.

The present study also closely approximates a recent study by Laughlin (1966). While the present investigation was similar to Laughlin's in the type of paradigm and stimuli used, it differed from Laughlin's in method of stimulus presentation (slide array), and in its introduction of postfeedback intervals. While Laughlin found four attribute concepts resulted in more use of focusing than two attribute concepts, more untenable hypotheses with two attribute concepts then four, and a significant relationship between focusing and scanning strategies, the present study failed to replicate these findings.

In addition to investigating the function of the postfeedback interval in concept attainment, the present study explored the relationship between perceptual style, as measured by the Witkin Embedded Figures Test, and performance on a conceptual task. It was hypothesized that the field-independent or analytical perceptual style was related to measures of conceptual performance. Low and non-significant intercorrelations between EFT scores and the five measures of conceptual performance failed to support this hypothesis.

In summary, the present study found a significant effect due to the postfeedback interval in a concept attainment task.

There was a significant difference between the 30" and 0" postfeedback interval groups for the dependent measure card choices to solution. There was a significant difference between the 30" and 15" interval groups for the dependent measure percentage of untenable hypotheses. There was also a significant interaction effect between attributes and interval for focusing strategy. While the facilitation effect due to the postfeedback interval has been demonstrated in earlier concept attainment research by Bourne, a reception paradigm was used in these investigations. The present study has demonstrated this postfeedback effect in concept attainment for a research design utilizing a selection paradigm.

Using the Embedded Figures Test as a measure of perceptual style, the present study found no significant relationships between the field-dependent, analytical style and any of the five response measures of conceptual performance.

CHAPTER V

SUMMARY

In order to determine the effect of introducing a postfeedback interval into a concept attainment problem in which stimuli were presented simultaneously, the performance of 72 college students was investigated for three concept attainment problems. Utilizing a selection paradigm, a 2 X 3 X 3 repeated measures factorial design was employed with the variables: (a) number of relevant problem attributes (two or four); (b) length of postfeedback interval (0, 15, or 30 seconds); (c) problems (three per subject). Five dependent measures of conceptual performance were: (1) card choices to solution, (2) focusing strategy, (3) scanning strategy, (4) number of untenable hypotheses, (5) percentage of untenable hypotheses. No main effects were found for attributes and problems. Significant effects due to the postfeedback interval were found for the response measures card choices to solution and percentage of untenable hypotheses. A significant interaction between attributes and interval for focusing strategy was also found. Finally, the present study also investigated the relationship between a subject's perceptual style, as measured by Witkin's Embedded Figures Test, and all five measures of conceptual performance. There were no significant relationships found between perceptual style and any of the five response measures of concept attainment.

References

Bauman, G. The stability of the individual's mode of perception and of perception-personality relationships. Unpublished doctor's dissertation, New York University, 1951. (Abstract)

Bourne, L. E., Jr. Human conceptual behavior. Boston: Allyn and Bacon, 1966.

Bourne, L. E., Jr., & Bunderson, C. V. Effects of delay of informative feedback and length of post-feedback interval on concept identification. Journal of experimental Psychology, 1963, 65, 1-5.

Bourne, L. E., Jr., Goldstein, S., & Link, W. E. Concept learning as a function of availability of previously presented information. Journal of experimental Psychology, 1964, 67, 439-448.

Bourne, L. E., Jr., Guy, D. E., Dodd, D. H., & Justesen, D. R. Concept identification: The effect of varying length and informational components of the intertrial interval. Journal of experimental Psychology, 1965, 69, 624-629.

Bourne, L. E., Jr., & Jennings, P. The relationship between response contiguity and classification learning. Journal of general Psychology, 1963, 69, 335-338.

Brown, F. G., & Archer, E. J. Concept identification as a function of task complexity and distribution of practice. Journal of experimental Psychology, 1956, 52, 316-321.

Bruner, J. S., Goodnow, J. J., & Austin, G. A. A study of thinking. New York: J. Wiley & Sons, 1956.

Cahill, H. E., & Hovland, C. I. The role of memory in the acquisition of concepts. Journal of experimental Psychology, 1960, 59, 137-144.

Dominowski, R. L. The role of memory in concept learning. Psychological Bulletin, 1965, 63, 271-280.

Gardner, R. W., Jackson, D. M., & Messick, S. J. Personality organization in cognitive controls and intellectual abilities. Psychological Issues, 1960, 2 (Whole No. 8).

Kurtz, K., & Hovland, C. I. Concept learning with differing sequences of instances. Journal of experimental Psychology, 1956, 51, 239-243.

References (continued)

Laughlin, P. R. Selection strategies in concept attainment as a function of number of relevant problem attributes. Journal of experimental Psychology, 1966, 71, 773-776.

Linton, Harriet B. Relations between mode of perception and tendency to conform. Unpublished doctor's dissertation, Yale University, 1952. (Abstract).

Longenecker, E. D. Form perception as a function of anxiety, motivation, and testing situation. Unpublished doctor's dissertation, Yale University, 1952. (Abstract).

Newman, S. E. Effect of contiguity and similarity on the learning of concepts. Journal of experimental Psychology, 1956, 52, 349-353.

Oseas, L., & Underwood, B. J. Studies of distributed practice: V. Learning and retention of concepts. Journal of experimental Psychology, 1952, 43, 143-148.

Peterson, M. J. Some effects of the percentage of relevant clues and resentation methods on concept identification. Journal of experimental Psychology, 1962, 64, 623-627.

Pikas, A. Abstraction and concept formation. Cambridge: Harvard University Press, 1966.

Richardson, J., & Bergum, B. Distributed practice and rote learning in concept formation. Journal of experimental Psychology, 1954, 47, 442-446.

Underwood, B. J. An orientation for research in thinking. Psychological Review, 1952, 59, 209-220.

Underwood, B. J. Studies of distributed practice: XV. Verbal concept learning as a function of intralist interference. Journal of experimental Psychology, 1957, 54, 33-40.

Witkin, H. A. Individual differences in ease of perception of embedded figures. Journal of Personality, 1950, 19, 1-15.

Witkin, H. A. Personality through perception. New York: Harper and Bros., 1954.

Witkin, H. A., Dyk, Ruth B., Faterson, Hanna F., Goodenough, D.R., and Karp, S. A. Psychological differentiation. New York: John Wiley, 1962.

Appendix 1 - Duncan Multiple Range Comparisons for Significant Differences Between the Three Postfeedback Intervals for Dependent Measures Card Choices to Solution, and Percentage of Untenable Hypotheses.

Card Choices to Solution-Effect for Intervals (0", 15", 30")

		I=0"	I=15"	I=30"
	Mean	20.62	16.91	12.95
			Difference	Difference
I=0"	20.62		3.71	7.67**
I=15"	16.91			3.95
I=30"	12.95			

Percentage of Untenable Hypotheses-
Effect for Intervals (0", 15", 30")

		I=0"	I=15"	I=30"
	Mean	44.96	65.35	41.76
			Difference	Difference
I=0"	44.96		20.39	3.20
I=15"	65.35			23.60*
I=30"	41.76			

*$p < .05$
**$p < .01$

Appendix 2 - Duncan Multiple Range Comparisons for Significant Differences between the Three Postfeedback Intervals for Two Attribute Problems, and for Four Attribute Problems for the Dependent Measure Focusing.

Focusing Strategy-Effect for Postfeedback Intervals (0", 15", 30"), For Two Attribute Problems.

		I=0"	I=15"	I=30"
	Mean	1.89	1.68	2.22
			Difference	Difference
I=0"	1.89		.21	.33
I=15"	1.68			.54*
I=30"	2.22			

Focusing Strategy-Effect for Postfeedback Intervals (0", 15", 30"), For Four Attribute Problems.

		I=0"	I=15"	I=30"
	Mean	1.90	2.02	2.12
			Difference	Difference
I=0"	1.90		.12	.22
I=15"	2.02			.10
I=30"	2.12			

*$p < .05$

Appendix 3 - Duncan Multiple Range Comparisons for Significant Differences Between Two and Four Attribute Problems Within the 0" Interval, 15" Interval, and 30" Interval For the Dependent Measure Focusing.

Focusing Strategy-Comparisons Between Two and Four Attribute Problems Within Intervals (0", 15", 30").

		2 Att.(0"I)	2 Att.(15"I)	2 Att.(30"I)
	Mean	1.89	1.68	2.22
		Difference	Difference	Difference
4 Att.(0"I)	1.90	.01		
4 Att.(15"I)	2.02		.34*	
4 Att.(30"I)	2.12			.10

*$p < .05$

APPROVAL SHEET

The thesis submitted by John M. Paolella has been read and approved by the director of the thesis. Furthermore, the final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Arts.

1/18/68
Date

Patrick R. Laughlin, PhD
Signature of Adviser