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Conditional Concept Formation Under Unequal Information Conditions

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CONDITIONAL CONCEPT FORMATION

UNDER

UNEQUAL INFORMATION CONDITIONS

BY

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LIFE

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CHAPTER I
INTRODUCTION

The past few years have witnessed a notable increase in investigation of the cognitive processes - the means whereby organisms achieve, retain, and transform information. The work of Bruner, Goodnow, and Austin (1956) represented a renewed effort to deal with one of the simplest and most ubiquitous phenomena of cognition: categorizing or conceptualizing. The spirit of their inquiry was descriptive. They sought to describe and in a small measure to explain what happens when an intelligent human being seeks to sort the environment into significant classes of events so that he may end by treating discriminably different things as equivalents.

The basis for inferring membership in a class for a particular object depends on the attributes of the object. The attributes, therefore, serve as signals which tell us the category of the object. An attribute is any discriminable feature of an event that is susceptible of some discriminable variation from event to event. When we say that any attribute may vary, we imply that any attribute represents a dimension along which one may specify values. The attribute of color may be represented by the values red, violet, blue, green, "Etc."

There are continuous gradations along it. Other attributes, those that vary discretely, have no such continuity. The simplest discrete attribute dimension is a binary one and this type is very common. A woman is married or not married, she is dead or alive, "Etc."

A range of values may also serve to define the exemplars of a category. For example, one of the defining attributes of the fruit orange is color. The positive value of the attribute is a range of colors from orange-yellow through red-orange. There are many discriminable hues that are "acceptable" as signals that the round object before one is an orange and is thus discriminable from other classes of things as lemons and grapefruits. The width of the range of positive values of an attribute that an individual will accept as a basis for categorization will vary from object to object.

Bruner, Goodnow, and Austin distinguished between three category types: conjunctive, disjunctive, and relational. They said that it was not usual to infer identity or some other significate from a single attribute exhibited by an instance, but from several attributes taken together. Illness, for example, is not inferred only from abnormal body temperature, but from a whole set of clinical signs taken in combination. Attributes or cues are combined for making inferences. The principal distinctions, conjunctive, disjunctive, and relational, each involve a different mode of combining attributes.

A conjunctive category or concept is one defined by the

joint presence of the appropriate value of several attributes. A disjunctive category is one defined by the presence of one attribute or as well by another attribute. A relational concept or category is one defined by a specifiable relationship between defining attributes. It is sometimes possible to describe the same grouping or class of instances in terms of two different combinations of attributes. One way of combining attributes may prove to be equivalent to another in terms of the groupings that result by use or application, i.e., it may turn out that one rule for combining attributes may prove to be equivalent to another.

Bruner, Goodnow, and Austin stressed the "invented" or "constructed" nature of a concept or category. The type of concept a person constructs out of the positive instances of the category he has met will determine the way in which he will categorize new instances encountered. When one learns to categorize a subset of events in a certain way, one is doing more than simply learning to recognize positive instances encountered. One is also learning a rule that may be applied to new instances. The concept or category is basically the "rule of grouping" and it is such rules that one constructs in forming and attaining concepts. In this sense, conjunctive, disjunctive, and relational categories are different types of rules for grouping a set of attribute values for defining the positive or exemplifying instances of a concept.

Bruner, Goodnow, and Austin suggested that disjunctive

concepts were more difficult to learn or identify than conjunct-
ive, although a direct comparison of the two types was not made.
The first systematic investigation of possible differences in rule
difficulty was reported by Hunt and Hovland (1960). These re-
searchers studied which of three different rules a subject would
choose if all were consistent with a particular grouping of
stimuli. Two of the rules were conjunction ("and") and disjunct-
ion ("and/or"). The third, called the relational rule, specifies
a certain relationship such as "greater than" or "equal to,"
between specific stimulus attributes. As an example, one relat-
ional concept used by these experimenters was, "Same number of
figures in the upper and lower portions of a stimulus card."
The subject was presented with a series of geometric designs,
some of which were labeled as negative. The instances were
selected in such a way that the positive class could be described
logically either as a conjunctive, a disjunctive, or a relational
concept. Which concept, if any, the subject discovered while
inspecting these stimuli, was determined in a subsequent series
of test trials. In the test, the subject was required to pick
out the stimuli which he thought were consistent with (were
positive instances of) the concept illustrated by the original
stimulus series. Conjunctive and relational concepts were chosen
with greater frequency than disjunctive concepts but did not
differ from each other.

Bourne (1966) interpreted frequency of choice as an
indication of the relative difficulty of each rule or type of

solution. On the basis of the Hunt and Hovland data, Bourne inferred that relational and conjunctive concepts were easier than disjunctives. He also raised a few additional questions in his survey of the literature in this area. For example, he asked: 1) Will the same result hold if we look at the learning process directly rather than require the subject to recognize positive instances after learning presumably has been completed? 2) If the result does hold up under various procedural conditions, what are the significant contributing factors? 3) Given that differences in difficulty among rules do exist, are they in any way affected by practice?

Conant and Trabasso (1964) and Neisser and Weene (1962) reported evidence related to the first two of these questions. In the Conant-Trabasso experiment, the subjects were required to discover the solution to structurally equivalent conjunctive and disjunctive problems under a selection paradigm. All subjects solved problems of both types, presented in counterbalanced order. Consistent with the conclusion of Hunt and Hovland, disjunctive concepts were reliably more difficult to solve than conjunctive. These researchers were able further to trace at least part of the difference between rules to the relative difficulty of negative and positive instances. In terms of logical information, negative instances were more valuable than positive when the solution was a disjunction while just the reverse was true for conjunctive problems. Conant and Trabasso showed that subjects learned more readily to use the information

available in positive instances, thus putting them at somewhat
of a disadvantage in disjunctive problems. From the earlier
results of Freibergs and Tulving (1961), however, differences
between conjunctive and disjunctive problems would be expected
to lessen or disappear with extensive practice in the use of
negative information. One additional finding in this experiment
was that subjects' card selections were more redundant
(provided overlapping information) in disjunctive problems.
This also may be due to the difficulty subjects had in under-
standing the full implications of a negative instance. Because
the information they contained was difficult to assimilate and
utilize, several stimuli providing essentially the same
information may be required by the subject.

The study reported by Neisser and Weene (1962) was
distinguished by its use of a large variety of different rules
for forming concepts. These experimenters showed that there
were ten different rules for generating nominal concepts based
on (at most) two relevant attributes. Further, they indicated
that these rules fell into three structurally different levels
of complexity. On Level I are two rules: affirmation - all
stimuli with attribute x are members of the concept; and
negation - all stimuli which do not display attribute x are
members of the concept. On the next higher level (II) were a
set of rules which specified either a conjunctive or disjunctive
combination of two attributes; for example, "x and y" or
"not x and/or y." Finally, on Level III are combinations of two

attributes which involve both conjunctive and disjunctive rules;
for example, "(x and y) and/or (not x and not y)." Successive
levels represented increasing conceptual (or rule) complexity
both in terms of the length of expression and in terms of
hierarchical structure. Concepts at each level were composed of
concepts from the next lower level. Neisser and Weene explored
the learning of concepts at each level on the assumption that
problem difficulty would increase with the structural complexity
of a concept.

Significant changes in difficulty were observed as the
level of concept increased. The outcome was interpreted as
reflecting a hierarchical organization of conceptual processes
within the subject. To attain a complex concept, the subject
must use, and therefore must have attained earlier, some simpler
concepts from lower levels. Complex learning and problem solving
is predicated on earlier and simpler learning processes. While
one may question this interpretation on several grounds (there
is no real evidence that the subjects did learn Level III
concepts as a combination of conjunctions and disjunctions),
the fact still remains that rule differences do exist in
significant degree, indicating again the real function of the
rule as an item of knowledge to be discovered and used in any
conceptual task.

More recently, Haygood and Bourne (1965) compared the
performance of human subjects on four different rules: conjunct-
ion, disjunction, joint denial (only patterns which are neither

A nor B are positive instances of the concept, where A and B are are the relevant attributes), and conditional (if a pattern contains A then it must also contain B to be a positive instance). There were three different conditions of learning. All subjects were given a series of five successive problems of the same type so that practice and transfer effects could be observed. For subjects working in the attribute identification condition, the required rule was explained and illustrated prior to the first problem and then described again between each successive problem thereafter. In the rule-learning condition, the two relevant attributes were named prior to each problem. Neither the rule nor the attributes were specified in complete learning. For any subject, the same rule held for all five problems, though the relevant attributes changed from problem to problem. The reception paradigm was used throughout.

Rules differed markedly in difficulty on problem one, with conditional and disjunctive rules producing the greatest numbers of errors and trials to solution. However, these differences gradually diminished with successive problems, indicating that at least part of the differences among rules may be a function of their relative familiarity. In general, performance was worst in complete learning conditions. Performance approached perfection over five rule-learning problems; that is, subjects made almost no errors on the fifth problem for three of the rules. Performance levels in attribute identification and complete learning conditions were nearly the same after five problems. The latter

finding suggested that the subjects did learn the rules in the course of training and that remaining differences among the rules were due to the difficulties each presented for identifying relevant attributes. It seems clear from this experiment that differences in rule difficulty arose from both sources discussed earlier. First, rules differ in and of themselves probably because subjects are more experienced with some (for example, conjunctive) than with others (for example, disjunctive). Second, rules differ because it was analytically or strategically easier to identify the relevant attributes for some.

The present research was focused on the conditional concept. General research in the area shows that the conditional concept is much more difficult than the conjunctive or disjunctive. Shephard, Hovland, and Jenkins (1961) explored the learning and memorization of six different types of classification, each containing two categories with an equal number of stimulus members. Two of the six classifications were based on the biconditional rule, one involving two, the other three relevant dimensions (Types II and VI respectively). Their interest was mainly the effect of the number of relevant or irrelevant dimensions on the learning and memorization of classifications. As the number of relevant dimensions increased (Type II versus Type VI), the number of irrelevant ones decreased. As such, their comparison provided no unambiguous information about the formation of the conditional concept itself.

The first study designed to examine the effects of irrele-

vant information in non-conjunctive concept problems was that
of Kepros and Bourne (1966). Using the biconditional rule, they
found a linear increase in problem difficulty as the number of
irrelevant dimensions increased. Haygood and Stevenson (1967)
compared the effects of number of irrelevant dimensions on
conjunctive, inclusive disjunctive, and conditional concept
formation. In their study, the biconditional was omitted because
of its extreme difficulty. A simple conditional was used instead.
The effect of increasing irrelevant dimensions was greater as
rule difficulty increased with conditional showing largest
increase in mean errors to solution, disjunctive next largest,
and the conjunctive rule the least.

A study performed by Laughlin and Jordan (1967) employed
conjunctive, disjunctive, and biconditional concepts. For the
criteria of number of card choices and time to solution,
disjunctive concepts were significantly more difficult than
conjunctive, but there were no differences between conjunctive
and biconditional. Laughlin and Jordan traced the differences
partly to the differences between selection and reception
procedures; since Haygood and Bourne used programmed sequences,
subjects were more likely to draw negative instances useful for
the solution of concept rules other than conjunctive, than would
be the case for the selection paradigm. Also, Haygood and
Bourne's four-attribute and three-value concept universe could
be contrasted with Laughlin and Jordan's six-attribute and
two-value universe; biconditional concepts could become

relatively more difficult than other types as the number of values per attribute increased.

Jacobson (1967) undertook a study to determine the relative difficulty of five conceptual rules under two conditions of memory demands. Three problems were given to eighty Loyola University undergraduate students. A 5 X 2 X 3 repeated measures factorial design was used with the variables: 1) Concept rule (conjunctive, exclusive disjunctive, exclusion, bi-conditional, and conjunctive absence), 2) Memory (paper allowed or not allowed), 3) Problems (three per subject). Five response measures were used to measure the relative difficulty of concepts: a) card choices to solution, b) focusing strategy, c) scanning strategy, d) time to solution in minutes, and e) untenable hypotheses. In general, the results showed that conjunctive concepts were easiest for subjects to attain. Conjunctive concepts were attained most readily as was reflected by each of the five response measures. Biconditional concepts were the most difficult to attain; the biconditional rule featured the most difficult solution on three response measures (card choices, scanning, and untenable hypotheses). The next most difficult solution was exclusive disjunction. The easiest solution after conjunctive was conjunctive absence. Intermediate in difficulty among all the rules was exclusion. The finding that biconditional and exclusive disjunction rules represented the most difficult solutions was consistent with previous research in the area.

Previous studies in conditional concept formation have

either employed the biconditional or the conditional concept in comparison to other rules such as the disjunctive or conjunctive. The purpose of the present study is to concentrate on the factors which go into the formation of the conditional concept itself.

A general selection paradigm, described by Bourne (1966), was set up. The stimulus population was presented to the subject. The problem began when the experimenter designated one member of the population as a positive instance of the concept which must be discovered. On the basis of this information, the subject guessed what the correct hypothesis was; that is, he stated some hypothesis about the solution. If the guess was wrong, the subject himself was allowed to select an instance from the population and to ask whether it was positive or negative. Once this question had been answered by the experimenter, the subject chose a new instance and revised his hypothesis according to the new information which he has received. This process continued - another instance was selected by the subject and categorized by the experimenter - until the subject stated the correct hypothesis; that is, the solution. In this first study of the conditional concept, this procedure was modified slightly. The attribute identification learning of Haygood and Bourne (1965) was also adopted.

Since the amount of information received would be vital to the subject, this variable was made the independent variable. Number of card choices to solution would be the criterion for problem solving. The more information a subject would receive,

the easier it would be for him to solve the problem. In the experimental paradigm, the amount of feedback information was divided into total and partial feedback. In the total feedback condition, the subject was told "Yes" when a positive instance of the conditional concept occured. Both the "If" and the "Then" factors were present on the card. He was told "Does-not-contradict" when the "If" factor was not present. Under this condition, the "Then" factor might or might not be present on the card. He was told "No" when the conditional rule was violated: The "If" factor was present on the card; the "Then" factor was absent. In the partial feedback condition, the subject was told "Yes" if the conditional rule was exemplified or not contradicted. He was told "No" when the rule was violated.

Besides information on feedback, there is a certain amount of information about the correct hypothesis given with the subject's first card. Either both factors of the conditional concept ("If" and "Then") will be present, both absent, or one of them will be present. If the first card contains both factors (Yes-Yes), it will be a "Yes" card in both the total and partial feedback conditions. When the "If" factor (No-Yes) or both factors (No-No) are absent on the first card, it will be a "Does-not-contradict" in the total, and a "Yes" card in the partial feedback conditions.

Keeping in mind the two types of information, namely on feedback and on first card, the experimental hypotheses were as follows:

Hypothesis 1. The greater the amount of feedback information, the fewer the number of card choices before the subject solves the problem.

Hypothesis 2. The greater the amount of information on the first card, the fewer the number of card choices before the subject solves the problem.

Hypothesis 3. An interaction effect might take place between amount of feedback information and amount of information on first card.

N.B. "Solving the problem" means discovering the proper conditional concept.

CHAPTER II

METHOD

Subjects: The subjects were 78 Major Seminarians from the following three Chicago suburban Major Seminaries: Divine Word Seminary, Techny, Illinois; Dominican House of Studies, River Forest, Illinois; Tolentine Center, Olympia Fields, Illinois.

Apparatus: The stimulus display was a 28 X 44 inch white posterboard containing an 8 X 8 array of 64 2½ X 4 inch cards drawn in colored ink with dark outlines. The 64 cards represented all possible combinations of six plus and minus signs in a row. Each position had a different color (e.g. first position was always blue). The name of the color was the attribute, while the plus or minus represented the value of each color; e.g. attribute red: value: minus. The cards were systematically arranged upon the display board. For example, the top four rows were blue plus and the bottom four rows were blue minus.

Procedure: The purpose of the different colors and signs on the sequence board was explained to each subject individually. This was done in the following way: Color was merely a positioning attribute which turned up in a plus or minus value on each card on the sequence board. It was possible to classify or categorize the cards according to attribute (color) and value

(plus or minus). This classification or categorization could be set up arbitrarily. Certain of the cards on the sequence board would exemplify the category and certain cards would not. In other words, it was possible to divide the 64 cards on the sequence board into those which exemplified the arbitrary category or classification and those which would not. An example of this was given to the subject by defining a category with a single attribute and a single value. The subject was then asked to name the cards by number which fit the category which we had arbitrarily set up. It was pointed out that on a single attribute and value, the board was cut in half: half of the cards exemplified the category and half did not.

The subject was then told that it was possible to define a category in as many as six attributes and two values. The subject was then given the possibilities of the values of the two attribute category to which we would limit ourselves today. The possible value combinations are: ++, --, +-, and -+. After each possibility was given, an example was made up and the subject was asked to point out by number, all the cards which the category.

It was then pointed out that what had been called a "category" or "classification" was the same thing as a concept. Some concepts were simple. They contained few elements. Others were more complex. They contained many elements. For experimental purposes, we could construct either very simple or very complex concepts with the sequence board. The purpose of the

sequence board was the study of concept formation.

The interest of the present study was in a special type of two attribute concept, namely, the conditional concept. The nature of the conditional concept in terms of "If" and "Then" factors was explained to the subject. All the possibilities of the values were pointed out and demonstrated: "If" factor +, "Then" factor +; "If" factor -, "Then" factor-; "If" factor +, "Then" factor -; "If" factor -, "Then" factor +. In each case, the subject was given an example and asked to choose the cards on the sequence board by number, which exemplified the concept. The subject was allowed to ask questions. At this point, the subject was also asked whether he had any. All questions were answered at this point.

The task was explained very briefly: on a sheet of paper, the experimenter had a particular two attribute two value conditional concept written down. The task of the subject was to find it. The conditional rule, typed on a small index card, was given to the subject. He was told to keep it and refer to it throughout the entire task. The conditional rule read as follows: "If the card has a particular value (plus or minus) on one color, then it must have a particular value on another color in order to be included in the concept. But if it does not have the particular value on the first color, then it does not need to have the particular value on the second color. Example: If black plus, then yellow plus. (But if black minus, then either yellow plus or minus.)"

The instructions differed slightly from here on for the partial and total feedback conditions. In the partial feedback condition, the subject was told: "The first card is a 'Yes' card." In the total feedback condition, the subject was told either: "The first card is a 'Yes' card"; or: "The first card is a 'Does-not-contradict' card."

The exact procedure was then explained. The subject would be given a card (which was a "Yes" or "Does-not-contradict"). He would have to make the choice of another card, designating his choice by calling out the card number. He was allowed to choose any card on the sequence board. He would be given the appropriate feedback: "Yes" or "No" on the partial feedback condition; "Yes," "No," or "Does-not-contradict" on the total feedback condition. Then the subject would be allowed to make a hypothesis. If the hypothesis was correct, the problem would be considered solved. If it was not correct, then the subject would have to make another card choice. Then he would be given the appropriate feedback as after his previous card choice. Then he would be allowed another hypothesis. He would be allowed one hypothesis per card choice. The idea was to try to solve the problem in as few card choices as possible. Time was going to be kept, but time was not an important factor in the experiment. The subject was told that there were three problems.

The following feedback information was typed on index cards available to the subject throughout the experiment. He was encouraged to refer to the cards during the course of his task.

For the total feedback condition, the information was as follows: "Yes: A 'Yes' answer to your card choice means that the card you have chosen fits the concept rule because it exemplifies it, that is, the correct hypothesis is contained on the card."

"No: A 'No' answer to your card choice means that the card you have chosen contradicts the concept rule. The correct hypothesis is not contained on the card. On a 'No' card, the 'If' factor will be present, but not the 'Then' factor."

"Does-not-contradict: A 'Does-not-contradict' answer to the card you have chosen means that the card does not fall under the concept rule. This would occur when the 'If' factor is not present, although the 'Then' factor might or might not be present."

For the partial feedback condition, the feedback information was as follows: "Yes: A 'Yes' answer to your card choice means either: 1) The card fits the concept rule because it exemplifies it, that is, the correct hypothesis is contained on the card. 2) The card fits the concept rule because it does not contradict it, that is the 'If' factor is not present, although the 'Then' factor might or might not be present."

"No: A 'No' answer to your card choice means that the card you have chosen contradicts the concept rule. The correct hypothesis is not contained on the card. On a 'No' card the 'If' factor will be present, but not the 'Then' factor."

Design: The design of the experiment was a 3 X 2 X 3 repeated-measures factorial:

Factor 1: Amount of Information on First Card:

Yes-Yes: The "If" and "Then" factors of the solution were on the first card.

No-Yes: The "If" factor of the solution was not on the first card, but the "Then" factor was.

No-No: Neither "If" nor "Then" factors of the solution were on the first card.

Factor 2: Amount of Information on Feedback:

Total: The subject is told "Yes," "No," or "Does-not-contradict" after each card choice.

Partial: The subject is told "Yes" or "No" after each card choice.

Factor 3: Three Problems were given to each subject.

CHAPTER III

RESULTS

The data were first analyzed for the dependent variable of number of card choices to solution. Although time to solution was not considered the basic dependent variable in the experiment, it too was analyzed. Throughout the results section, the following abbreviations are used: C - Card Choice, F - Feedback, and P - Problems.

Card Choices to Solution: The mean card choices to solution for the conditional concept are given in Table 1.

Table 1

Mean Number of Card Choices to Solution for Three Problems and Totals over Problems.

First Card:	Feedback					
	Partial			Total		
	Y-Y	N-Y	N-N	Y-Y	N-Y	N-N
Problem:						
One:	10.9	17.3	14.2	4.7	9.1	7.3
Two:	10.9	9.3	19.8	7.0	14.0	5.7
Three:	13.8	7.3	13.8	4.0	7.3	7.6
Total:	35.6	33.9	47.8	15.7	30.4	20.6

Results of the analysis of variance for card choices are given in Table 2.

Table 2

Analysis of Variance for Number of Card Choices to Solution.

Source of Variance:	d.f.	S.S.	M.S.	F
Card Choice (C)	2	353.77	176.88	<1
Feedback (F)	1	1850.28	1850.28	7.80*
C X F	2	639.90	319.95	1.35
Error (B)	72	17074.67	237.14	
Problems (P)	2	200.33	100.16	<1
P X C	4	382.67	95.67	<1
P X F	2	70.01	35.00	<1
P X C X F	4	830.28	207.82	1.73
Error (W)	144	17271.99	119.94	

*$p < .01$

Thus, in terms of the experimental hypotheses, the results were as follows:

Hypothesis 1: The greater the amount of feedback information, the fewer the number of card choices before the subject solves the problem. This hypothesis was verified. There was a strong effect of amount of feedback information on the number of card choices to solution, as total feedback required fewer card choices than partial, F (1,72) = 7.80, $p < .01$.

Hypothesis 2: The greater the amount of information on the first

card, the fewer the number of card choices before the subject solves the problem. As is apparent from Table 2, the effect of first card information on number of card choices was not significant, F (2,72) = <1. Therefore the second hypothesis was not verified.

Hypothesis 3: An interaction effect might take place between amount of feedback information and amount of information on first card. As is apparent from Table 2 card choices, none of the interactions were significant. Therefore this hypothesis was not verified.

Time to Solution in Minutes: The mean time to solution in minutes is given in Table 3. Results of analysis of variance

Table 3

Mean Time to Solution in Minutes for Three Problems and Totals over Problems.

	Feedback					
	Partial			Total		
First Card:	Y-Y	N-Y	N-N	Y-Y	N-Y	N-N
Problem:						
One:	26.8	33.7	41.5	15.0	16.3	21.2
Two:	18.3	15.0	37.4	14.7	16.5	15.0
Three:	20.3	13.6	27.5	9.8	11.8	16.2
Total:	65.4	62.3	106.4	39.5	44.6	52.4

for time to solution are given in Table 4. As is apparent from

Table 4

Analysis of Variance for Time to Solution in Minutes.

Source of Variance:	d.f.	S.S.	M.S.	F
Card Choice (C)	2	4061.78	2030.89	3.09
Feedback (F)	1	6914.46	6914.46	10.53*
C X F	2	1558.25	779.12	1.18
Error (B)	72	47274.42	656.58	
Problems (P)	2	3460.91	1730.56	5.86**
P X C	4	343.06	85.79	<1
P X F	2	913.12	406.56	1.37
P X C X F	4	1085.34	271.33	<1
Error (W)	144	42520.01	295.27	

*$p < .01$.

**$p < .01$.

Table 4, the analysis of variance for mean time to solution paralleled the analysis of variance for mean number of card choices. The effect of feedback information was significant in terms of less time for the total over the partial feedback information condition, $F_{(1,72)} = 10.53$, $p < .01$. In terms of information on first card, the difference between the total and partial feedback information conditions for time to solution approached, but did not exceed the critical value of F (3.12) at the .05 level of significance, $F_{(2,72)} = 3.09$. difference between problems in terms of minutes per problem was

significant at the .01 level, F (2,144) = 5.86. The results of Duncan Multiple Range Tests showed that problem one took significantly more time than problem three ($p < .01$), while problems one and two, and problems two and three, did not differ significantly.

CHAPTER IV

DISCUSSION

The results of the experiment were quite straightforward.
In terms of feedback information, significantly fewer card
choices were required in the total than in the partial feedback
condition. In terms of information on the first card, however,
there was no significant difference between the two conditions.
In other words, the subject seemed to have benefited more by
feedback information than by information on the first card.

In explanation, we might further analyze exactly what kind
of information was on the first card. In the partial feedback
condition, the subject was not told what factors of the concept
were on the card. From the onset, he knew only that the first
card was a "Yes" card. In one case, both factors of the con-
ditional concept were actually on the card. In the second case,
the "If" factor was not present, but the "Then" factor was pres-
ent. In the third case, neither factor was present. Since the
subject did not know from the onset to which group he belonged,
the first card would not help him much.

In the total feedback condition, the subject only knew that
some parts of the concept were present, he did not know what
they were. For instance, when the first card was a "Yes" card,

he knew only that the "If" factor and the "Then" factor were present. He did not know what they were. He could only find this out by comparing the first card with other cards. In this process, he would have to rely largely on feedback information.

The first card in the total feedback condition was a "Does-not-contradict" card when the "If" factor was absent and the "Then" factor present, or when both factors were absent. In the total condition also, the subject could only find out what the actual factors were by comparing the first card with other cards. Again, he would have to rely largely on feedback information. The content of the information on first card was ambiguous. This ambiguity could only be eliminated by utilizing feedback information. Since previous research (Bruner, Goodnow, and Austin, 1956; Haygood and Bourne, 1965) indicates that the subject learns the rule as he procedes in solving the problem, the information on the first card seems too tenuous for him to grasp at the beginning of the search for the solution. We might conclude that the subject would not pay close attention to the information on the first card.

The analysis of variance for time to solution lends some support to this viewpoint. Significantly less time $(p < .01)$ to solution was required in the total than in the partial feedback condition. The focus of the subject, in terms of time consumed, was on feedback information. In terms of time consumed on first card, the difference between partial and total feedback conditions only approached, but did not reach significance at

the .05 level. In the present experiment, the subject did not seem to have focused on the first card.

There was a practice effect in terms of time to solution over three problems, but not in terms of number of card choices. The subject did not make significantly fewer card choices over the three problems, but he made his choices in less time. Duncan Multiple Range Tests showed that problem one took significantly more time than problem three, though the differences between problems one and two, and two and three were not significant. A gradual progress from the first to the third problem appeared in terms of time only. This effect points to the fact that the problems or the task itself grew easier after the first problem. If so, this result is in accord with the previous studies of Haygood and Bourne (1965) and Jacobson (1967).

Two suggestions for future research could be made from the present experiment in regard to information on first card. First, a clearer delineation of the kind of information on the first card could be made. The subject could be told the value of one of the factors of the solution, for instance, or which of the factors was present or absent on the first card. Secondly, a "No" card or negative instance of the rule could be used as a first card. Previous research (Freibergs and Tulving, 1961; Neisser and Weene, 1962; Conant and Trabasso, 1964) indicates that a negative instance of the concept is more helpful in solving disjunctive problems such as the conditional, than a positive instance. Such a clear point of reference as a first

card might make a significant difference both in terms of number
of card choices and time to solution as regards future research
with the conditional concept.

CHAPTER V

SUMMARY

In order to assess the effect of information on the formation of the conditional concept, the performance of 78 Major Seminarians was investigated in three conditional concept attainment problems. A 2 X 3 X 2 repeated measures factorial design was used with the following two information conditions: total and partial feedback, and amount of information on first card (Yes-Yes; No-Yes; No-No). There were significantly fewer card choices ($p < .01$) in the total than in the partial feedback information condition, even though amount of information on the first card made no significant difference in number in number of card choices. The analysis of variance for the time factor paralleled these results except that the time factor in regard to information on the first card approached significance. There was a significant difference in terms of time per problem ($p < .01$), but no effect for number of card choices. Gradual progress was noted over the three problems not in terms of number of card choices, but in terms of time. In regard to first card information, two suggestions were made for future research: First, a clearer delineation of the type of information on the first card; Second, use of a negative instance of the rule as a first card.

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APPROVAL SHEET

The thesis submitted by Reverend Paul LaForge has been read and approved by the director of the thesis. Furthermore, the final copies have been examined by the director 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.

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Date

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