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Effects of Varying Amounts of Discussion on Concept Attainment Strategies and Interproblem Transfer

by

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A Thesis Submitted to the Faculty of the Graduate School

of Loyola University in Partial Fulfillment of

the Requirements for the Degree of

Master of Arts

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Life

Jon Anthony Anderson was born in Chicago, Illinois, February 1, 1944.

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Introduction

Much, if not most, of the interaction between an individual and his environment involves dealing with classes or categories of things. The tremendous diversity one encounters in everyday life is necessarily coded into a smaller number of categories to simplify the environment. The process by which concepts are acquired and used are of typical interest to psychologists.

In concept attainment problems an arbitrary scheme (e.g. conjunctive rule) combines certain attributes to define a concept. The subject is required to discover the concept through an inductive process based on the observation of a set of positive and negative instances. Information about the correct concept is presented in bits and pieces, on a trial-by-trial basis, until the subject arrives at the solution.

One of the oldest questions in problem solving concerns comparisons of group and individual efforts. Within this general area, the concept of social facilitation is central, but over the past several decades previous research has given conflicting results: compared with the solutions arrived at by individuals working in isolation, problem solving in a group is sometimes facilitative and sometimes inhibiting. Hare (1962) rather unspectacularly concluded that "the presence of others working on the same task has been found to stimulate some individuals to greater productivity, distract others, and leave others unaffected." The group situation may either increase an individual's activity if he is motivated by implied competition, or depress activity through distraction, conformity to norms, or group resistance to the task. "Most studies can be seen as dealing with the same fundamental problem of identifying the factors which define optimal conditions for maximum productivity in problem solving (Van de Geer and Jaspers, 1966)."

A number of studies have been concerned with how the skills of the group members combine. Although there is some evidence (Ryack, 1965) for a pooling model, it seems that the group problem situation is typically more than just a combination of individuals who just happen to be in a group. In this respect, Hall, Mouton, and Blake (1963) showed in tasks requiring several complex judgements, that interacting groups were significantly superior to the pooled scores of the separate individuals. That there may, under certain circumstances, also be an interactive effect on the abilities of individual members was demonstrated by Goldman (1965), who found that the partner of lower ability in a two-man group increased his ability as a result of the group problem solving experience. Thus, a task such as concept attainment in which there is room for considerable improvement in the abilities of the individual members may get an added impetus due to the increase in problem solving skill of low ability members. Under these circumstances a simple pooling model is inadequate for predicting performance. Thomas and Fink (1961) indicated that a pooling ("independence") model may be applicable for complex tasks, however, if discussion or communication between group members was not possible--or not allowed.

Attempts to relate the outcome of a group's problem solving efforts to the ability of the group members have been beset by two basic problems: differences in task demands of the many types of problems used, and the consequent difficulty of specifying the particular abilities relevant to the tasks. While it may be true, for example, that mathmatical reasoning scores on general intelligence tests are positively correlated with individual success on deductive reasoning problems, they are completely uncorrelated with success on certain sudden insight problems. Hoffman (1965) has brought up these difficulties and noted that experimental evidence as to any relationship between member ability and group proficiency is inconsistant.

Apart from the differences between individual and group and the way in which the abilities of the group members combine, several other factors have been examined in group studies. "Two factors appear to stand out as facilitating effective problem solving: the members' motivation to work cooperatively on the problem, and the diversity of the points of view and information relevant to the problem within the group (Hoffman, 1965)."

Hoffman (1961) has attributed the success of heterogeneous groups in problem solving to the presence of more different kinds of ideas or different possible directions available for approaching the problem. But unless given a free atmosphere in the group, the right solution may be suppressed (Maier & Solem, 1952). It is apparent that even when diversity exists in a group, the varied viewpoints are not always heard. If all ideas are to be communicated and considered by the group then, it is important that they be aired and discussed. The best known factor in this area--which has not been too clearly distinguished from social facilitation--has to do with the effect of brainstorming instructions on effective and creative problem solving.

Osborn (1953) offered the brainstorming technique in which an evaluation-free period of idea production helps prevent discard of potentially good solutions before all ideas are in. The technique has been used primarily in applied research, and since there have been no experimental tests of the superiority of brainstorming to free discussion in the problem solving situation it is very difficult to evaluate. The value of discussion of some sort to effective problem solving, though, is unquestionable.

In the concept attainment situation, where the complex nature of the task makes a long-range, in-depth view of the situation particularly beneficial, the effects of discussion are most important.

Most studies of conceptual behavior have employed one or another variation of what has been called the reception paradigm--in which the experimenter successively presents stimuli to the subject. A more recent and widely used methodological development is the selection paradigm, owing largely to the work of Bruner, et al. (1956). In this situation the subject is presented with an array of cards varying in number of attributes (shape, color, etc.) with two or more values of each attribute (triangle or square, red or green, etc.). The experimenter then arbitrarily designates a combination of two or more values as a concept, and indicates an initial card satisfying this concept. The subject's task is to then determine the pre-designated combination by choosing a series of cards, learning whether or not each card exemplifies the concept, and thus solving the problem in as few card choices as possible (Laughlin and McGlynn, 1968).

In contrast to the reception technique, "Where the subject is in a sense at the mercy of the experimenter (Bourne, 1966)," in the selection paradigm the subject gathers information on his own. This technique makes it possible to determine from stimulus selections (and corresponding hypotheses) whether or not the subject is using any systematic plan of attack or strategy in the problem. If he knows how to go about it, he can use very effective strategies, and acquire the necessary information in a minimum number of trials (Bourne, 1966).

Bruner et al. (1956) distinguished between two basic strategies, Focusing and Scanning, in the concept attainment situation. In scanning, the subject tests specific hypotheses either singly (successive scanning), all at once (simultaneous scanning), or some intermediate number. While simultaneous scanning is the theoretically optimal strategy to minimize card choices to solution, it has been found too difficult for most people to use because of excessive inference and memory demands. As a result, many persons adopt a strategy of focusing in which attributes rather than specific hypotheses are tested. In focusing, the subject tests the relevance of all the possible hypotheses concerning a particular attribute or attributes by choosing a card differing in one (conservative focusing) or more (focus gambling) attributes from a positive focus card. A positive choice card indicates that the value changed is irrelevant to the concept, a negative choice card that it is essential. Memory and inference requirements are thus lessened, which Bruner et al. interpret as the explanation for focusing being generally a more effective strategy. Laughlin (1965, 1966) has formulated quantitative rules for the scoring of focusing and scanning strategies for conjunctive problems.

Laughlin and McGlynn (1968) have noted that although this paradigm has been applied primarily to studies of individual cognitive processes, recent studies have related it to group problem solving. Laughlin (1965) found that two person cooperative groups required fewer card choices to solution, had fewer untenable hypotheses, and adopted a focusing strategy more than individuals. After application of the Taylor-McNemar correction model (1955) the group superiority in terms of card choices was no longer found, but their advantage in terms of focusing strategy remained.

Laughlin and Doherty (1967) analyzed this group superiority in terms of the relative influence of discussion and memory factors, comparing conditions in which discussion and paper were or were not allowed to cooperative pairs. Discussion groups solved the problems in fewer card choices and fewer untenable hypotheses than groups not allowed discussion; memory had no effect. Complex relationships were found for the adoption of focusing and scanning strategies in the interactions of discussion, memory, stimulus display, and rule difficulty.

The effects of discussion were made clear when Laughlin and McGlynn (1968) found that two cooperative individuals were more effective in problem solving than two competitive individuals in terms of number of card choices to solution, fewer untenable hypotheses, and more use of focusing strategy, although they required more time. Through discussion the cooperative pairs were able to monitor and evaluate each other's card choices and hypotheses and develop the empirically more effective focusing strategy. Cooperative groups were thus found to hold the same advantage over competitive groups as groups over individuals. No sex differences were found in problem solving performances or the use of strategies, although males required more time. This was taken to indicate that usual male superiority in problem solving (Duncan 1961; Van de Geer & Jaspers, 1966) may be due to motivation rather than capacity. It was concluded that the concept attainment situation was sufficiently interesting for females to motivate their performance on a level with males.

In the Laughlin and McGlynn study, a steady imporvement over five problems was found in terms of number of card choices, focusing strategy, and number of untenable hypotheses which was attributed to a social facilitation effect found in both cooperative and competitive pairs. But this finding represents a departure from the continuity of this line of research. Laughlin and Jordan (1967) had noted that interproblem transfer did commonly take place with experimenter programming of instance or reception strategies (e.g. Neisser & Weene, 1962; Wells, 1962; Wells & Watson, 1965; Haygood & Bourne, 1965) and did not occur with subject selection of instances (e.g. Bruner et al., 1956; Conant & Trabasso, 1964; Laughlin, 1966). And the Laughlin and Jordan and Laughlin and Doherty studies have supported this observation. But the interproblem transfer found by Laughlin and McGlynn (1968) raised a new question as to whether selection paradigm studies could, in fact, commonly expect to find no interproblem transfer effects.

The existence of discussion as an aid in concept attainment is clear (Laughlin & Doherty, 1967; Laughlin & McGlynn, 1968), but there is question as to how this process effects the improvement, or advantage, over non-discussion situations.

Thus, the present experiment investigated interproblem transfer effects and the role of discussion in the concept attainment situation. This was accomplished by varying the amount of discussion allowed to cooperative groups on three conjunctive problems. It was expected that increasing amounts of discussion would result in more efficient problem solving in terms of greater use of focusing strategy, fewer untenable hypotheses, and fewer card choices to solution. Analysis of the effects of discussion was made both in terms of problems and hypotheses.

Method

Design and subjects. A 3 x 3 x 3 repeated measures factorial design was used with the variables: (1) discussion allowed on problems (first, first and second, all three); (2) discussion allowed on hypotheses (first two, first four, first six), (3) problems (three for each pair of subjects).

Subjects were 180 students (90 male and 90 female) from two Chicago schools, Mundelein College and Loyola University. Ten like-sex pairs (half male, half female) were randomly assigned to each of the nine experimental conditions.

Stimulus display and problems. The stimulus display was exactly the same as that used by Laughlin and McGlynn (1968): a 28 x 44 inch white posterboard containing an 8 x 8 array of 64 2 1/4 x 4 inch cards drawn in colored ink with dark outlines. The 64 cards represented all possible combinations of six attributes with two levels of each. The display consisted of all combinations of six plus and/or minus signs in a row. In order to facilitate reference to the six positions, each was a different color, so that the color name was the attribute and plus or minus the value of each color. The 64 cards were arranged systematically in relation to the other cards, for example, the first color (blue) was plus in the top four rows, minus in the bottom four. The problems were conjunctive concepts with three relevant attributes (e.g. "blue minus, green plus, red plus"). Each problem and initial card for each pair of subjects was randomly assigned from the set of three-attribute conjunctive concepts and the subset of possible initial cards for each subject. All pairs solved three problems.

Procedure. The meaning of conjunctive concepts was thoroughly explained to the subjects, and the concept rule was typed on a reference card accessible to them throughout the experiment. The instructions explained the nature of the task, pointed out the systematic arrangement of the attributes and values on the display, and emphasized that the problems were to be solved in as few card choices as possible, regardless of time (Laughlin, 1964).

All pairs were told to work together and that they could discuss the problems and their card choices and hypotheses. They were told to alternate in actually selecting each card and stating the accompanying hypothesis... "because at some point during the problem I will stop the discussion after which you may not communicate except to state your card choices and hypotheses in turn."

The person who selected the first card and made the first hypothesis was determined by a coin flip before the first problem. Subjects then alternated in starting off the second and third problems.

Results

Four response measures were analyzed: number of card choices to solution, focusing strategy, percentage of untenable hypotheses, and time to solution.

Card choices to solution. The mean number of card choices to solution for the nine treatment groups for each of the three problems are presented in Table 1. A summary of the analysis of variance is presented in Table 2.

The effect of problems (the number of problems on which discussion was allowed) was significant at the .001 level, $F\ (2,81) = 8.617$. Duncan multiple-range comparisons were performed on the three problem conditions summing over the three hypotheses conditions. Discussion on two problems was significantly superior to discussion on just one problem ($p < .05$). And discussion on all three problems was significantly superior both to discussion on two problems ($p < .001$) and to discussion on one problem ($p < .001$).

The analysis of variance also revealed a significant effect for hypotheses (the number of hypotheses on which discussion was allowed), $F\ (2,81) = 4.9547$, $p < .01$. Duncan multiple-range comparisons were performed on the three hypotheses conditions summing over the three problem conditions. There was a progressive improvement in the number of card choices to solution, varying directly with the number of hypotheses on which discussion was allowed. Discussion on four hypotheses required significantly fewer card choices than discussion on two hypotheses ($p < .01$). Discussion on three hypotheses required significantly fewer choices than either four ($p < .05$) or two ($p < .001$) hypotheses. There was no significant effect on card choices due to trials (first, second, and third problems). None of the interactions were significant.

Focusing Strategy. The rules for scoring focusing strategy were taken from Laughlin (1965) and Laughlin and Jordan (1967). They are given in detail below.

Table 1

Mean Number of Card Choices for the Nine Discussion Conditions for Three Trials

Discussion Problems-Hypotheses	Trials 1	2	3	Total
one-two	5.4	6.6	5.8	17.80
one-four	5.5	6.9	5.3	16.70
one-six	4.8	4.7	4.9	14.40
two-two	5.2	5.4	4.5	15.10
two-four	4.4	5.1	4.8	14.30
two-six	4.8	3.5	4.0	12.30
three-two	4.7	5.0	4.8	14.50
three-four	4.5	4.1	3.4	12.00
three-six	4.4	3.8	3.5	11.70
Total	4.86	5.01	4.56	14.43

Table 2

Summary of Analysis of Variance for

Card Choices to Solution

Source	df	SS	MS	F
Problems (P)	2	80	40.0	8.617***
Hypotheses (H)	2	46	23.0	4.9547**
P x H	4	9	2.25	
Error (B)	81	376	4.5420	
Trials (T)	2	10	5.0	1.23
T x P	4	11	2.75	
T x H	4	16	4.0	
T x P x H	8	12	1.5	
Error (W)	162	658	4.067	

** $p < .01$

*** $p < .001$

Rule 1: Each card choice had to obtain information on one new attribute. New information was obtained if the card choice altered either one attribute not previously proven irrelevant (conservative focusing), or more than one attribute (focus gambling), providing that in altering more than one attribute, the instance was either positive or that the ambiguous information was correctly resolved on the next card choice 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 three types: (a) a hypothesis for a value of an attribute when the other value had previously occurred on a positive instance; (b) a hypothesis which had previously occurred on a negative instance, and (c) a repetition of a previously given hypothesis.

Each card choice and accompanying hypothesis that satisfied these 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 derive a focusing score on a continuum from .00 to 1.00.

The mean focusing scores for the nine treatment groups for each of the three problems are presented in Table 3. A summary of the analysis of variance is presented in Table 4.

The analysis revealed a significant effect of discussion over problems, $F\ (2,81) = 9.1925$, $p < .001$. Duncan multiple-range comparisons were performed on the three problem conditions summing over the three hypotheses conditions. Discussion on two problems proved to be significantly superior in terms of focusing scores than discussion on just one problem ($p < .001$). And discussion on three problems was significantly more conducive to higher

Table 3

Mean Focusing Scores for the Nine

Discussion Conditions for Three Problems

Discussion	Trials			
Problems-Hypotheses	1	2	3	Total
one-two	.486	.341	.423	1.250
one-four	.449	.291	.511	1.251
one-six	.453	.468	.513	1.434
two-two	.472	.421	.495	1.388
two-four	.630	.641	.447	1.718
two-six	.479	.714	.562	1.755
three-two	.626	.572	.536	1.734
three-four	.635	.719	.716	2.070
three-six	.498	.667	.699	1.864
Total	.525	.537	.545	1.607

Table 4

Summary of Analysis of Variance for Focusing

Source	df	SS	MS	F
Problems (P)	2	1.6712	.8356	9.1925***
Hypotheses (H)	2	.3366	.1683	1.8515
P x H	4	.2017	.0504	
Error (B)	81	7.3669	.0909	
Trials	2	.0171	.0086	
T x P	4	.4287	.1072	1.5163
T x H	4	.4267	.1067	1.5092
T x P x H	8	.3800	.0475	
Error (W)	162	11.4509	.0707	

***$p < .001$

focusing scores than both discussion on two problems ($p < .01$) and discussion on one problem only ($p < .001$). There were no significant effects due to hypotheses or trials.

Untenable hypotheses. The mean percentages of untenable hypotheses for the nine treatment groups for each of the three problems are presented in Table 5. A summary of the analysis of variance is presented in Table 6.

The analysis of variance revealed a significant effect for hypotheses, $F(2,81) = 4.231$, $p < .05$. Duncan multiple-range comparisons were performed on the three hypotheses conditions summing over the three problem conditions. Discussion on six hypotheses was found to reduce significantly the percentage of untenable hypotheses as compared with discussion on four hypotheses ($p < .01$) and discussion on just two hypotheses ($p < .001$). The difference between four hypotheses and two hypotheses, however, was not significant. There were no other significant main effects and there were no significant interactions.

Time to solution. The mean time to solution (in minutes) for the nine discussion groups for each of the three problems is presented in Table 7. A summary of the analysis of variance is presented in Table 8.

The analysis of variance revealed a significant effect for trials, $F(2,162) = 29.5633$, $p < .001$. Duncan multiple-range comparisons between problems revealed that the second problem required significantly less time to solve than the first ($p < .001$), and the third problem required significantly less time to solve than either the second ($p < .001$) or the first ($p < .001$). There were no other significant main effects and there were no significant interactions.

Table 5

Mean Untenable Hypotheses Ratios for the Nine

Discussion Conditions for Three Problems

Discussion Problems-Hypotheses	Trials 1	2	3	Total
one-two	.259	.451	.353	1.063
one-four	.377	.329	.239	9.45
one-six	.178	.219	.239	6.36
two-two	.333	.302	.241	8.76
two-six	.223	.195	.222	6.40
three-two	.254	.283	.331	8.68
three-four	.162	.168	.195	5.25
three-six	.251	.093	.158	5.02
Total	.246	.256	.248	7.50

Table 6

Summary of Analysis of Variance for

Untenable Hypotheses

Source	df	SS	MS	F
Problems (P)	2	.3144	.1572	2.2172
Hypotheses (H)	2	.6007	.3004	4.231*
P x H	4	.1058	.0266	
Error (B)	81	5.7421	.0709	
Trials (T)	2	.0055	.0029	
T x P	4	.1072	.0268	
T x H	4	.1038	.0260	
T x P x H	8	.3448	.0431	
Error (W)	162	7.0235	.0433	

*$p < .05$

Table 7

Mean Times to Solution for the Nine

Discussion Conditions for Three Problems

Discussion	Trials			
Problems-Hypotheses	1	2	3	Total
one-two	12.1	10.1	7.2	29.4
one-four	11.9	10.0	5.2	27.1
one-six	10.0	5.8	4.7	20.6
two-two	10.6	7.7	4.7	23.0
two-four	9.6	7.6	6.2	23.4
two-six	12.4	6.1	4.7	23.2
three-two	11.2	8.8	7.0	27.0
three-four	9.9	7.0	5.1	22.0
three-six	10.4	7.2	6.4	24.0
Total	10.91	7.81	5.69	24.41

Table 8

Summary of Analysis of Variance

for Time to Solution

Source	df	SS	MS	F
Problems (P)	2	31.341	15.6705	1.0245
Hypotheses (H)	2	75.652	37.8260	
P x H	4	105.704	26.4261	
Error (B)	81	2,990.566	36.9206	
Trials (T)	2	1,241.564	620.782	29.5633***
T x P	4	28.725	7.1814	
T x H	4	53.081	13.2703	
T x P x H	8	63.653	7.9456	
Error (W)	162	3,401.734	20.9984	

***$p < .001$

Correlations between the response measures (card choices to solution, focusing strategy, untenable hypotheses, and time to solution) over all conditions, both for individual problems and summing over the three trials, are presented in Table 9.

Discussion

The major purpose of this experiment was to examine the role of discussion in the concept attainment situation. Previous evidence had well established its importance in group problem solving (e.g. Hoffman, 1961; Maier & Solem, 1952). Basically the results were as expected: increasing amounts of discussion had significant effects in facilitating the problem solving process. This was indicated by decreasing numbers of card choices, increasing focusing scores, and decreasing numbers of untenable hypotheses. Laughlin and Doherty (1967) and Laughlin and McGlynn (1968) had also noted the importance of discussion in concept attainment with similar results.

As Laughlin and Doherty (1967) had noted, the benefits of discussion seem to involve an inference and monitoring process, in which the two persons can both reason concerning the meaning of each card choice and hypothesis and check each other. Through discussion they can reduce erroneous inference and insure more efficient card choices, thus solving the problems in fewer card choices and making fewer untenable hypotheses.

The differing effects of discussion over problems and discussion over hypotheses found in this experiment offer an explanation of the discussion process in concept attainment. As discussion was allowed over more hypotheses the number of card choices to solution decreased and the percentage of untenable hypotheses decreased. As dissussion was allowed over more problems, the card choices to solution decreased and the incidence of focusing

Table 9

Intercorrelations of Response Measures

Individual Problems	Focusing	Un. Hypotheses	Time
Card Choices	-.67	.67	.59
Focusing		-.70	-.39
Un. Hypotheses			.33

Summing Over Problems	Focusing	Un. Hypotheses	Time
Card Choices	-.71	.69	.54
Focusing		-.77	-.33
Un. Hypotheses			.27

increased. The percentage of untenable hypotheses was influenced more by discussion over hypotheses than by discussion over problems; and focusing reflected variation in discussion over problems more than discussion over hypotheses. Card choices to solution--the basic dependent measure (Laughlin and Doherty, 1967)--however, was influenced by both discussion over problems and discussion over hypotheses.

These results suggest that the discussion process in the concept attainment situation can be separated into different functions. The two response measures of focusing strategy and percentage of untenable hypotheses reflected the different functions of discussion. Card choices, the more basic indicator, reflected both functions.

It seems that as subjects were allowed discussion over more hypotheses, they were better able to reduce the number of mistakes made (in terms of untenable hypotheses). If a person who perceives an untenable hypothesis on the part of his partner is free to correct it through verbal interaction under discussion conditions, it follows that the more hypotheses on which discussion is allowed, the smaller the percentage of untenable hypotheses will be, (providing, of course, that the mistake is perceived). But assuming that the perception of errors equal across all conditions, the manipulation of discussion can be seen to have direct effect on the percentage of untenable hypotheses. What is most important, is the fact that discussion over hypotheses is most responsible for the reduction of untenable hypotheses.

As subjects are allowed more discussion over problems, however, they are given the opportunity to discuss more of the complete process. An increase in discussion over hypotheses does not always reflect this, but any increase in discussion over problems reflects prior experience in solving at least one problem. Discussion under these conditions, i.e. after prior relevant problem solving experience, would then, based on experience, be of a more sophisticated, and therefore more profitable, nature in terms of overall strategy.

It should be noted that the results of increased discussion over problems reported here, i.e. increased focusing, do not imply the superiority of that strategy over scanning, but rather only increased efficiency. For Laughlin and Doherty (1967) noted, discussion facilitates the effective utilization of whatever strategy is used, whether focusing, or scanning.

In summary, then, the discussion process in concept attainment can be seen as having two main effects, avoidance of mistakes or untenable hypotheses, and adoption and utilization of an efficient strategy. While there was no effect of discussion on time to solution, there were highly significant transfer effects over all three problems in regard to time. This is a curious result in view of the fact that none of the other response measures reflected any transfer effects. There is some question as to whether time to solution should be considered a response measure in terms of performance. Laughlin and Doherty (1967) and Laughlin and McGlynn (1968) both found fewer card choices, lower percentages of untenable hypotheses, and more efficient use of strategies with discussion, yet more time to solution. This paralleled the results of Laughlin (1965) which indicated that groups required more time than individuals. This study failed to replicate this effect of discussion on time, however, and raised some question as to what time to solution is measuring. A possible explanation (McGlynn, 1968) is that time, which subjects were instructed to ignore, may be taken as a measure of organization and coordination as much as a measure of performance. If time is taken as a measure of organization, then, the results can be used to support the usual failure to find transfer effects in selection paradigm experiments.

As Laughlin and Jordan (1967) noted: transfer is commonly found in reception paradigm studies (e.g. Neisser and Weene, 1962; Wells, 1962; Wells and Watson, 1965; Haygood and Bourne, 1965), but not in selection paradigm studies (e.g. Bruner et al., 1956; Conant and Trabasso, 1964; Laughlin, 1966). The failure of the present study to find any transfer effects for card choices, focusing, or percentage of untenable hypotheses is in essential agreement with this observation.

While the consideration of time as a measure of organization and coordination helps to clear up the situation somewhat, there is still seemingly no explanation for the failure of the previously cited selection paradigm experiments to find transfer effects for time to solution. Nor does there seem to be an explanation for the finding of the Laughlin and McGlynn (1968) study of transfer effects for all measures, including time to solution.

The correlations between response measures are substantially the same for individual problems and for the sum of each group's three problems. These correlations are very close to those reported by McGlynn (1968) for conjunctive problems given to cooperative groups. The correlations in this study are also in general agreement with those reported in Laughlin and Jordan (1967) and Laughlin (1966), though somewhat higher than those of the latter study. In comparison with the Laughlin and Doherty (1967) study, though, the correlations reported here are consistently much higher, with one complete reversal. The Laughlin and Doherty study reported a correlation of −.33 between time to solution and card choices, whereas the present study found a positive correlation between these two measures of .59. This is curious in view of the fact that both studies used conjunctive problems in group situations. Both studies also varied the amount of discussion allowed, though the Laughlin and Doherty study used either full discussion or no discussion conditions.

The difference in the time-card choice correlations are reflected in the different findings of the two studies concerning discussion and transfer effects on time to solution. While both studies found that discussion resulted in fewer card choices, more focusing, and lower percentage of untenable hypotheses, the Laughlin and Doherty study found more time to solution and the present study did not. And while both studies found no transfer effects in terms of card choices, strategy, or untenable hypotheses, the Laughlin and Doherty study found no transfer effect for time to solution either, whereas the present study did.

The agreement of these two experiments on correlations of other response measures, at least as to uniform direction, and the substantial similarity of results other than those concerning time to solution raise further question as to the consideration of time as a measure of performance...at least in terms of cognitive efficiency.

Summary

The effects of varying amounts of discussion on concept attainment strategies and interproblem transfer were investigated for three successive three-attribute conjunctive problems. Using the selection presentation method, individuals in two-person cooperative groups alternated in selecting successive instances from an array containing all possible instances and in making each accompanying hypothesis. This alternation took place under both conditions: where discussion was or was not allowed. The stimulus display

was a six-attribute, two-value systematic array of 64 cards. A 3 x 3 x 3 repeated measures factorial design was used with the variables: (1) discussion allowed on problems (first, first and second, all three), (2) discussion allowed on hypotheses (first two, first four, first six), (3) problems (three for each pair).

Increasing amounts of discussion significantly decreased the number of card choices to solution, increased the incidence of focusing, decreased the percentage of untenable hypotheses, but had no effect on the time to solution. Increases in discussion over problems and discussion over hypotheses had different effects: the former resulted in reduction of the percentage of untenable hypotheses, the latter resulted in a higher incidence of focusing, while both resulted in fewer card choices to solution.

There was a highly significant transfer effect over all three problems found for time to solution. No other transfer effects were found. It was suggested that perhaps time might better be considered a measure of organization and cooperation within the group, rather than as a performance indicative of cognitive efficiency.

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Appendix I

Instructions

This is an experiment in thinking. There are 64 cards on this board, arranged in 8 rows if 8 cards each and numbered from one to 64. These cards are all the possible combinations made by taking six colors, each color being either a plus or a minus. (The 6 colors were pointed out, each as a plus and a minus.) The colors are called attributes, and the plus or minus signs are called values.

These cards can be grouped together or categorized in a large number of possible ways by following a specified rule. The rule defines a concept, and a concept is the group of all cards that satisfy the rule.

The rule is that the card must have a particular value (plus or minus) on one color, a particular value on another color, and a particular value on a third color. For example, all the cards with a blue plus, an orange plus, and a green minus are the concept "blue plus, orange plus, and green minus." Or, all the cards with a black minus, a green plus, and a red plus are the concept "black minus, green plus, and red plus."

In the problems I will have some concept in mind, and your job is to determine what it is. I'll start you off by giving you the number of one of the cards that is included in the concept; that is, one of the cards that exemplify the concept I have in mind. Then you will select any card you wish in order to get information as to whether the card you select is also included in the concept. If the card you selected is included in the concept, I will say "yes," and if the card you selected is not included in the concept, I will say "no". To be included it must have all three attributes and values specified in the rule. (An example was given of a card that only partially satisfied the rule.)

Then you will make a hypothesis as to what concept you then think I have in mind. If your hypothesis is correct, I'll say "yes," and you've solved the problem. If your hypothesis is not correct, I'll say "no". A "no" means that your hypothesis is not entirely correct. It may be entirely wrong, or it may be partly correct. (A parallel example to the one given previously was given of a partially correct hypothesis.)

If I say "no," you select another card, and again I'll say "yes" or "no" depending upon whether the card you select is included in the concept, and again you will make a hypothesis and I'll say "yes" or "no" to the hypothesis. So, you just keep repeating the procedure of selecting a card and making a hypothesis, selecting another card and making another hypothesis, until you've solved the problem.

Now you're going to be working together on the problems, so you can discuss your card choices and hypotheses all you want...up to a point. After that...after I tell you no more discussion is allowed...you'll still be working together, but discussion will no longer be allowed. To prepare for this, you are to alternate in actually saying each card choice and hypothesis from the beginning of each problem. For instance, if you were to start (pointing to one subject) you would make the first card choice and accompanying hypothesis verbally, though you might have decided upon it together. Then it would be your turn to say the next card and hypothesis (pointing to the other). You must establish the pattern of alternating because at some point during the problem I will stop the discussion after which you may not communicate except through your card choices and hypotheses.

There are three problems in all, and the object is to solve each problem in the fewest number of card choices, regardless of time.

The concept rule was reiterated and the reference card placed in front of the subjects. Any questions were then answered.

At the beginning of the second and third problems subjects were told that they could begin discussing again.

At the point at which discussion was to end for each problem subjects were told: "from now on, no more discussion will be allowed; all you may say now is card numbers and hypotheses, in turn."

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APPROVAL SHEET

The thesis submitted by Jon Anthony Anderson 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	Signature of Adviser