THE DIFFERENTIAL EFFECTS OF VERBAL REINFORCEMENT ON THE PROBLEM-SOLVING EFFICIENCY OF HIGH AND LOW ACHIEVEMENT GROUPS

A Thesis

Presented to

the Department of Psychology

The Kansas State Teachers College of Emporia

In Partial Fulfillment

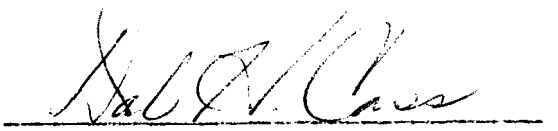
of the Requirements for the Degree

Master of Science

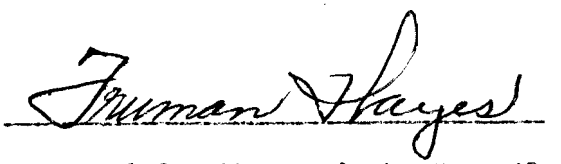
by

James R. Meeker

August 1969



Approved for the Major Department



Approved for the Graduate Council

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS USED

I. INTRODUCTION

Research has indicated that certain personality characteristics make some individuals more amenable to verbal conditioning than others. As Zigler and Kanzer have put it, "This practice of treating social reinforcers as if they were homogeneous pellets dispenses to equally hungry rats was recently called into question. . ."[1] The present study investigated the possibility of using academic achievement potential as a criterion for differentiating group reaction to verbal conditioning.

Other studies have pointed out that the problem-solving ability of a group is directly related to the number of participations made by that group. "Group discussion," wrote Barnlund, "was found to stimulate more careful thinking, to lead to consideration of a wider range of ideas, and to provoke more objective and critical testing of conclusions."[2] Since social reinforcement can influence the amount of group participation, it can also influence the problem-solving efficiency of a group.

---

[1]Edward Zigler and Paul Kanzer, "The Effectiveness of Two Classes of Verbal Reinforcers on the Performance of Middle- and Lower-Class Children," Journal of Personality, XXX, (June, 1962), 157.

[2]Dean C. Barnlund, "A Comparative Study of Individual, Majority, and Group Judgment," The Journal of Abnormal and Social Psychology, LVIII (January, 1959), 60.

In summary, the present study was based on the assumption that a group's reaction to verbal reinforcement is directly related to the academic achievement potential of that group. Furthermore, the amount of group participation is highly correlated with problem-solving ability. Thus it was assumed that when groups differing in achievement potential are equally reinforced for participation, their problem-solving efficiencies are unequally affected.

II. THE PROBLEM

Statement of the problem. The problem presented by this study can be expressed as follows: Does the effect of positive verbal reinforcement influence a high academic achievement group differently from a low academic achievement group with regard to problem-solving efficiency? Academic achievement was measured by the American College Test (hereafter, simply ACT), and group participation was the factor receiving reinforcement.

Significance of the study. The present study is pertinent to the educational process for several reasons:

1. Problem solving and group participation are central factors in most educational settings. Consequently, information regarding the functional relationships between problem solving and group dynamics can directly benefit educators.

2. It is a common practice for college admissions personnel to use the ACT to place students in special classes based on their

achievement potential. Relationships found between group performance and ACT scores can assist in this placement.

3. Verbal reinforcement is often used as a universal panacea for the problems of nonparticipation and low efficiency in the classroom. The major importance of this study resides in the fact that verbal reinforcement may not be equally beneficial to students of varied academic ability.

Statement of hypotheses. The type of problem-solving task used in this experiment relied on two criteria to measure efficiency: the number of questions asked by the subjects and the number of problems solved within the time limit. Eight research hypotheses were generated using verbal reinforcement and academic achievement as independent variables (controlled inputs), while questions asked and problems solved were dependent variables (measured results). Expressed in their null form the hypotheses are as follows:

1. There is no significant difference between high and low achievement groups with respect to the number of questions asked.

2. There is no significant difference between high and low achievement groups with respect to the number of problems solved.

3. Reinforcement conditions make no significant difference in the number of questions asked by high achievement groups.

4. Reinforcement conditions make no significant difference in the number of problems solved by high achievement groups.

5. Reinforcement conditions make no significant difference in the number of questions asked by low achievement groups.

6. Reinforcement conditions make no significant difference in the number of problems solved by low achievement groups.

7. When under conditions of reinforcement, there is no significant difference between high and low achievement groups with respect to the number of questions asked.

8. When under conditions of reinforcement, there is no significant difference between high and low achievement groups with respect to the number of problems solved.

III. DEFINITION OF TERMS USED

The terms which follow are key concepts in the present study. They are defined to assist the reader in understanding the material.

High achievement. High achievement refers to a composite score of twenty-six scale score points or better on the ACT. Normative data taken between 1964 and 1967 show a composite score of twenty-six points as having a percentile rank of 88.[3]

Low achievement. Low achievement refers to a composite score of fifteen scale score points or below on the ACT. Normative data taken

---

[3]The American College Testing Program, Using ACT on the Campus '68 - '69 (Iowa City: The American College Testing Program, Inc., 1968), p. 12.

between 1964 and 1967 show a composite score of fifteen points as having a percentile rank of 19.[4]

Group. A group consisted of from four to five individuals arranged in such close physical proximity that each member could freely respond to any other member. Due to the dynamic properties of the group, social motives become relevant which do not show up when each individual is working alone.[5] Thus, a group was an entity in itself and not merely a summation of individual acts.

Problem-solving efficiency. The problem-solving task used in the present study relied heavily on deductive reasoning and very little on specifically learned material. Consequently, it was the reasoning or information utilizing process itself which was under investigation. Operationally defined, efficiency was a combination of two factors: the number of information units needed to reach the solution (as measured by the number of questions answered by the experimenter) and the speed of performance (as measured by the number of problems solved during the thirty minute experimental period).

Participation. A participation was operationally defined as a meaningful word, phrase, or sentence bounded on both sides by a change

---

[4]Ibid.

[5]Barry E. Collings and Harold Guetzkow, A Social Psychology of Group Processes for Decision-Making (New York: John Wiley and Sons, Inc., 1964), p. 34.

in speakers. Nonmeaningful utterances, such as laughter and sighs, were not counted as participations.

Positive verbal reinforcement. Certain events have the property of strengthening almost any behavior with which they are associated. Such events are referred to as generalized reinforcers, and one of the most common is the word "good".[6] The present study used the word "good" pronounced in a flat unemotional tone as a positive verbal reinforcement.

Statistical significance. A generally used criterion for hypothesis testing is to reject any hypothesis which could have occurred by chance five times out of a hundred (.05 level). This study did not accept any hypothesis as scientifically verified knowledge which could not be confirmed at the .05 level of significance.

IV. LIMITATIONS OF THE STUDY

There is little doubt that an investigation such as this, which relied on a single population of subjects, has its limitations. The most serious limitation was the degree to which the findings could be generalized to a population different from the one investigated. Whenever possible, the present study strengthened its findings by citing supportive data from other research populations. However, the reader

---

[6] B. F. Skinner, Verbal Behavior (New York: Appleton-Century-Crofts, Inc., 1957), p. 54.

should remember the population used was a sample, and the results are directly relevant only to that sample, not the population as a whole.

A second limitation lies in the type of problem-solving task used. It is doubtful that any one task will ever measure all types of problem solving. The reader must therefore use caution when comparing the present results to other, less related types of problem-solving behavior.

Although not a formal part of this study, several correlation coefficients were calculated between group problem-solving efficiency and the amount of participation. These calculations had several limiting factors. First, even though two events are correlated, the reader must not assume that one event necessarily caused the other. Secondly, the recording of participations was complicated because of the high speed with which some groups emitted responses and difficulty in determining whether a speech unit was a participation or a meaningless utterance. These factors must be considered when interpreting the correlation coefficients.

CHAPTER II

REVIEW OF RELATED LITERATURE

Most experiments done in the field of verbal conditioning follow the basic framework developed by B. F. Skinner. Skinner makes several basic assumptions: that linguistic behavior does not differ fundamentally from other types of human behavior, that the problems of verbal behavior can be understood through a reinforcement model, and that many of man's problem-solving endeavors are characterized by verbal behavior.[1]

Joel Greenspoon is probably the man most responsible for the surge of interest in verbal manipulation through reinforcement. In Greenspoon's now classic experiment, reinforcement was made contingent on the statement of two general word classes, plural nouns and non-plural nouns. Furthermore, two types of verbal reinforcers were used, a positive reinforcer consisting of 'Mm-hmm' and a negative reinforcer consisting of 'Huh'uh'.[2] Greenspoon found that social reinforcement affects the class of words as a whole rather than specific words within the class. He also found that not only does the reinforcer affect the response, but the nature of the response in turn determines the effect of the

---

[1]B.F. Skinner, Verbal Behavior (New York: Appleton-Century-Crofts, Inc., 1957), p. 430.

[2]Joel Greenspoon, "The Reinforcing Effect of Two Spoken Sounds on the Frequency of Two Responses," The American Journal of Psychology, LXVIII (September, 1955), 410.

reinforcer.[3] With these findings, Greenspoon foreshadowed the present study. That is, certain factors outside the reinforcement determine the effect it will have.

Right after Greenspoon's pioneering work, a rash of verbal conditioning experiments appeared in the professional journals. These experiments seemed to center around two basic problems: how general are the effects of social reinforcement and what social reinforcers are most effective? William Verplanck found that almost any form of agreement could serve as a social reinforcer, and that classes of verbal behavior as large as opinion statements could be conditioned.[4]

Hildum and Brown investigated the effects of 'Um-hmm' and 'Good' on the expressions of opinion statements. Their results indicated that the word 'Good' has a significant influence on a person's expressed attitude while 'Um-hmm' does not. They explained their findings by pointing out that 'Good' has a more clearly favorable meaning, while 'Um-hmm' is often ambiguous and may even indicate disapproval.[5]

These early experiments most often attempted to reinforce a specific word class, i.e. plural nouns or statements of opinion. More

---

[3] Ibid., p. 415.

[4] William S. Verplanck, "The Control of the Content of Conversation: Reinforcement of Statements of Opinion," The Journal of Abnormal and Social Psychology, LI (November, 1955), 668.

[5] Donald C. Hildum and Roger W. Brown, "Verbal Reinforcement and Interviewer Bias," The Journal of Abnormal and Social Psychology, LIII (July, 1956), 111.

recent research has addressed itself to the problem of reinforcing any type of meaningful verbalization without regard for its specific content or class. It is interesting to note that this general approach has recently become prevalent in the field of psychotherapy, especially when working with withdrawn subjects. For example, in order to help a withdrawn patient, the therapist may start by reinforcing any type of verbalization made by the subject. This practice of reinforcing verbal behavior in general was the method used in the present study.

Sarbin and Allen attempted to influence the amount of verbal participation of group members by using agreement as a positive verbal reinforcement. As expected, the results indicated that an initially low participation rate could be significantly increased through verbal conditioning.[6]

It is appropriate at this point to mention a problem-solving study done by Arthur Staats. Staats used a pendulum problem to measure the effects of verbalization on problem solving. He found that verbal participation significantly increased an individual's problem-solving ability.[7] If one views Sarbin and Allen's findings in conjunction with

---

[6]Theodore R. Sarbin and Vernon L. Allen, "Increasing Participation in a Natural Group Setting: A Preliminary Report," The Psychological Record, XVIII (January, 1968), 1.

[7]Arthur W. Staats, "Verbal and Instrumental Response-Hierarchies and their Relationship to Problem-Solving," The American Journal of Psychology, LXX (September, 1957), 446.

the findings of Staats, the results are directly relevant to the present study. Verbal fluency increases problem solving, and social reinforcement increases verbal fluency.

The majority of past experiments were concerned with the effects of various verbal reinforcers on assorted classes of verbal behavior. As a result, strikingly few experiments were reported which attempted to isolate the personality factors responsible for the differential reaction of individuals to verbal conditioning. One notable exception was Irwin Sarason's investigation using psychiatric patients to determine what personality variables make some individuals more willing to "accept" social reinforcement. Sarason reinforced verbal activity in general using 'Um-hmm" as a reward. The subject's reaction to the conditioning was then correlated with his personality make-up. The results indicated that social agreeability or compliance was related to a heightened responsiveness during conditioning. Defensiveness, on the other hand, was related to a weakened reaction.[8] Other researchers have borne out this general conclusion. Marlowe, for example, indicated that individuals having strong tendencies to respond in a socially appropriate way are likely to be tied closely to the reward properties of the situation.[9]

---

[8]Irwin G. Sarason, "Interrelationships Among Individual Difference Variables, Behavior in Psychotherapy, and Verbal Conditioning," The Journal of Abnormal and Social Psychology, LVI (May, 1958), 344.

[9]David Marlowe, "Need for Social Approval and the Operant Conditioning of Meaningful Verbal Behavior," Journal of Consulting Psychology, XXVI (No. 1, 1962), 82.

It is interesting to note that Gough mentions social extroversion and a tendency to rely on others as being characteristic of the under achiever.[10] In other words, a strong reliance on others for social approval seems to characterize the under achiever as well as the highly conditionable individual.

Elizabeth Douvan went a step further and explained the differential reaction of individuals to conditioning on the basis of their socioeconomic background. Douvan stated,

> Success-failure cues in any situation should, among middle class children, elicit a relatively consistent reaction, irrespective of the reward conditions of the specific situation. Since working class children are taught achievement strivings neither so early nor so systematically their reactions to success-failure cues should be more responsive to changes in the reward potential of the situation. . .[11]

Thus, she hypothesized that lower socioeconomic class youth would show a significantly greater change in their achievement strivings under external reward conditions than would middle class youth. In order to test her hypothesis, Douvan selected high school students from both social classes and had them work on an anagram problem-solving task under two reward conditions. The first condition was rewarding

---

[10]Harrison G. Gough, "Factors Relating to the Academic Achievement of High-School Students," The Journal of Education Psychology, XL (February, 1949), 75.

[11]Elizabeth Douvan, "Social Status and Success Strivings," The Journal of Abnormal and Social Psychology, LII (March, 1956), 219.

only through the internal satisfaction received by attaining a predetermined norm. The second condition consisted of reaching the norm and receiving an external reward of ten dollars.[12] The results showed that the achievement strivings of the lower class adolescents dropped significantly under conditions of self-reward. The middle class subjects, however, remained approximately the same when under conditions of either external or internal reward.[13] These findings indicate that while lower class individuals are highly dependent on outside reinforcement, middle class adolescents rely more on an internalized reinforcing system. Middle class youth seem equipped with a generalized and stable reward system which keeps their behavior relatively constant regardless of the current outside reinforcing situation.[14]

Other researchers have found that low academic achievers tend to come from lower socioeconomic backgrounds.[15] This finding, when viewed in relation to Douvan's research, suggests that low achievers are more dependent on outside reinforcement than high achievers. This hypothesis is directly in line with the statement made previously about under achievers and highly conditionable individuals being dependent on external social approval. As Bruner put it, effective problem-solving activity comes only after the individual has been freed from the

---

[12] Ibid., p. 220. [13] Ibid., p. 223. [14] Ibid., p. 222.

[15] James V. Pisco and Paul H. Bowman, "Motivation Patterns of Superior High School Students," The Gifted Student, Cooperative Research Monograph No. 2 (Washington: U. S. Government Printing Office, 1962), p. 55.

immediate control of environmental rewards. Learning which is based on rewards from others often develops into patterns of seeking cues about how best to conform.[16]

The present chapter provided information which gave direction to this study. The critical hypotheses suggested by the above research can be summarized as follows:

1. Verbal behavior can be used as an index of group interaction and is subject to the same experimental analysis as any behavior.

2. Almost any form of approval can be reinforcing; however, certain reinforcers seem more consistent in their effects. The word "good" is one such reinforcer.

3. Social compliance and a tendency to rely on others for social approval are personality factors which relate to a heightened responsiveness during verbal reinforcement. Similar factors seem characteristic of the under achiever. One may hypothesize that the under achiever shows a strong tendency to "accept" social reinforcement.

4. Lower socioeconomic class adolescents are highly dependent on outside reinforcement, where as middle class youth seem to rely on an internalized reward system. Since low achievers tend to come from lower socioeconomic areas, one may again hypothesize that they show a heightened reaction to verbal conditioning.

---

[16]Jerome S. Bruner, "The Act of Discovery," Harvard Educational Review, XXXI (No. 1, 1961), 26.

CHAPTER III

DESIGN OF THE STUDY

I. SUBJECTS

The subjects used in this study consisted of undergraduates enrolled in Introduction to Psychology at Kansas State Teachers College of Emporia during the second semester of the 1968-1969 academic year. High achievers (composite ACT score of twenty-six points or better) were enrolled in accelerated classes, while low achievers (composite ACT score of fifteen points or below) were enrolled in remedial classes. Five experimental (with reinforcement) and five control (without reinforcement) groups were randomly drawn from the high population. The same number of experimental and control groups were randomly drawn from the low population.

Due to the fact that some subjects failed to participate in the experiment as planned, the groups ranged from four to five individuals. However, the major groupings (high control, high experimental, low control, and low experimental) were balanced so as to have twenty-two individuals in each. Thus, eighty-eight individuals took part in the experiment.

Since a given individual was placed in either a control or an experimental group, the randomization was done by tossing a coin. If the toss was "heads," the subject was placed in a control group, and if the toss was "tails," the subject was placed in an experimental group.

II. INSTRUMENTATION

American College Test (ACT). The ACT test battery is composed of four subjects: a section in English, mathematics, social studies, and natural science. The test items are constructed so as to measure nonacademic potential as well as academic potential. That is, the emphasis is placed on what the subject can do with learned material rather than specific subject matter.[1] In this respect, the ACT is similar to the problem-solving task used in the present study.

"Twenty Questions" problem-solving task. The task used in the present study consisted of a variation of Taylor and Faust's "Twenty Questions" problem. The problem seems particularly relevant to this study for the following reasons:

1. To find the solution in the most efficient manner, the subjects must use a high level of conceptualization.

2. The solution is not as artificial as many problem-solving experiments, because it is not obtained by a series of exact and well defined steps. In this respect, the task resembles the type of problem solving encountered in everyday life.

---

[1]The American College Testing Program, Using ACT on the Campus '68 - '69 (Iowa City: The American College Testing Program, Inc., 1968), p.4.

3. The procedure seems quite interesting to college undergraduates, and thus motivational and cooperation factors are sustained.[2]

4. No special apparatus or laboratory space is needed and the experiment requires only thirty minutes to complete.

5. A number of scoring criteria are available. These include the amount of assistance provided by the experimenter, the number of problems completed within the time period, and the number of intergroup participations made in reaching the solution.

Although the need for validity has long been apparent in problem-solving experiments, the matter has never been solved very satisfactorily. However, as Ray points out, the answer to whether the task really demands problem-solving behavior can be avoided by describing it completely enough that the reader can make his own judgement.[3]

The problem used in this study consisted of a list of ten common objects which were to be guessed one at a time. The groups were instructed to discuss among themselves and decide the best questions to ask the experimenter in order to gain clues about the objects. Thus the groups formed hypotheses based on information obtained from the

---

[2]Donald W. Taylor and William L. Faust, "Twenty Questions: Efficiency in Problem Solving as a Function of Size of Group," Journal of Experimental Psychology, XLIV (November, 1952), 360.

[3]Wilbert S. Ray, "Complex Tasks for Use in Human Problem-Solving Research," Psychological Bulletin, LII (March, 1955), 146.

questions, and as more information was gained, more specific questions were formulated. The questions, however, had to be worded so that the experimenter could answer them with "yes," "no," "sometimes," or "partly." If a question was phrased so that it could not be answered with one of these replies, the subject was asked to rephrase it. The groups were informed that only twenty-five questions were allowed on each item; therefore they must choose their questions wisely. If an item had not been guessed within twenty-five questions, instructions were given to try the next object.

So that there would be no misunderstanding, each subject was given a mimeographed copy of the instructions to follow as the experimenter read them aloud (see Appendix A). The instructions emphasized group cooperation and a mutual exchange of ideas. Each group was told they would receive a score based on the number of questions asked per object and the number of objects solved within the thirty minute time limit. Obviously, the fewer questions asked and the more problems solved, the greater the problem-solving efficiency.

III. PROCEDURE

Construction of equivalent problem lists. Since the groups were often drawn from the same class, there existed the possiblity that some subjects would discuss the task with fellow class members. In order to control such information leakage, the instructions urged the subjects not to discuss the experiment with their classmates (see Appendix A).

This measure was felt to be somewhat inadequate; therefore, five equivalent problems lists were constructed (see Appendix B). These lists were administered so that members of the same class received different but equivalent lists.

The following procedure was used to insure that the five lists would be equivalent in difficulty. Ten general categories (see Appendix C) were chosen, and five objects were arbitrarily picked from each category. The result was to have five arbitrary problem lists with ten objects per list.

A measure of difficulty for each object was then determined by administering the lists to a sample of twenty-five subjects. The subjects were randomly chosen, using the table of random numbers, from a middle (neither high nor low) section of introduction to psychology. Each subject solved one complete list, so that every list was tried five times. The difficulty of each object within a given category was then determined by calculating the average number of questions needed to guess that object.

Five final problem lists were then constructed by using a simple Latin square design (see Appendix B). The Latin square, in effect, systematically counterbalanced each list with regard to difficulty.

The reader should note, however, that the levels of difficulty are not comparable from category to category. In other words, the most difficult item in one category may have required fewer questions than the most difficult item in another category. For this reason, the Latin

square model was somewhat misrepresentative. In order to double check the equivalency of each list, a single-classification analysis of variance was run on the actual number of questions used for each object. The F value obtained from this analysis was 0.027. One finds that the F value must exceed 3.78 in order for a significant difference to exist at the 0.01 level. In other words, there is very little difference between the five problem lists with regard to difficulty.

The reader may well ask if a group starting with the easiest word in a category would have an advantage over a group starting with the most difficult word. Since both the control and experimental populations had five subgroups within them, both populations were administered lists one through five. Thus every major group (high control, high experimental, low control, and low experimental) received the same treatment with regard to the order of presentation.

Control of biasing factors. Recent research in verbal conditioning has shown that the experimenter's expectancies can significantly bias the results of the study. The experimenter may unintentionally transmit information to one group over another.[4] By taking into account these biasing factors, one can apply certain techniques to regain some of the lost control.

---

[4]Robert Rosenthal, "Covert Communication in the Psychological Experiment," Psychological Bulletin, LXVII (May, 1967), 356.

Each group was arranged in a circle so as to promote participation. The experimenter was seated outside the circle and avoided both direct and indirect contact with the subjects. The only time the experimenter entered into the group's conversation was to apply the reinforcement and to answer properly stated questions. It was hoped that this minimal participation would reduce visual and auditory cues which might bias the experiment.

As mentioned earlier, each subject was given a mimeographed copy of the instructions to follow as the experimenter read them aloud. This precaution allowed no variation in wording which might give cues to one group and not to another.

The effect of leadership on group performance is one of the most difficult variables to control in group research. In order to prevent one person from dominating the experiment by asking all the questions, the subjects were required to take turns asking the group's question (see Appendix A). The spokesman changed after each question, rotating in a clockwise manner.

It has long been thought that subjects tested earlier in an experiment tend to react differently from subjects contacted later in the experiment.[5] Simply because of the time difference, outside variables may appear which affect subjects in the latter stages of the experiment. The present study attempted to minimize these intervening

---

[5]Ibid., p. 360.

variables by alternating the groups. In other words, a high control group was followed by a low control group, and a high experimental group was followed by a low experimental group. This pattern was repeated in a cyclic fashion throughout the experiment. By using such an alternation, no one major group appeared first in the experiment, and the biasing factors were spread equally over each group.

Application of reinforcement. The word "good" was dispensed on a sixty second interval schedule with the requisite that a group member be engaged in a participation act at the moment of presentation. That is, in the event no one was verbalizing at the end of the sixty second period, the reinforcement was presented at the first participation made when a subject resumed talking. The questions used to gain clues were not reinforced neither were nonmeaningful utterances, such as laughter and sighs. Since the experimental period lasted for thirty minutes, each group received thirty reinforcements.

Collection of data. In an effort to increase the reliability of the data collection, a prepared recording sheet was used. The sheet had a space for the number of "yes," "no," "sometimes," and "partly" questions used on each object. There was also a space to record the number of participations made in reaching each solution. A participation was counted as a stretch of speech bounded before and after by a change in speakers. The questions used to gain clues were not counted as participations. The reader will remember from chapter one that the recording

of participations was complicated because of the high speed with which they were often emitted and the difficulty in determining whether or not a speech unit was a participation by definition.

IV. ANALYSIS OF DATA

The general procedure used to test the eight research hypotheses of this study can be expressed as follows:

1. In order to determine the effect of the achievement variable alone, one can compare the high control groups with the low control groups. Hypotheses one and two were tested by comparing the mean of the high controls with the mean of the low controls.

2. To determine the effect of the reinforcement variable alone, one can compare the experimental groups with their controls. Hypotheses three and four were tested by comparing the mean of the high experimentals with the mean of the high controls. Hypotheses five and six were tested by comparing the mean of the low experimentals with the mean of the low controls.

3. The interaction of both achievement and reinforcement variables can be determined by comparing the high experimental groups with the low experimental groups. Hypotheses seven and eight were tested by comparing the mean of the high experimentals with the mean of the low experimentals.

The above comparisons were made using either the mean number of questions asked or the mean number of problems solved, depending on the

hypothesis being tested. One difficulty was encountered when comparing the number of questions used. Groups solving a larger number of problems would obviously use more questions. Since one measure of efficiency is the number of questions asked, faster working groups are penalized. This difficulty was remedied by comparing only those questions used up to a given problem. The cut off problem varied from list to list and was determined by the slowest group to try a given list. Since every major group (high experimental, high control, low experimental, low control) tried lists one through five, the end result was to have a common cut off point of twenty-one objects for the comparison of questions asked.

A pooled variance t formula was chosen to test each null hypothesis that two group's means do not differ significantly. The degrees of freedom for such a model is $n_1 + n_2 - 2$.[6] Since an exact directional prediction of the outcome was not justified, a two-tailed test was used to interpret the t results.

A product-moment correlation was calculated between the total number of participations made by each subgroup and the group's problem-solving ratio. This problem-solving ratio was obtained by dividing the number of problems solved by the number of questions asked. Thus, as a group's problem-solving efficiency increased, the ratio increased in direct proportion.

---

[6]James V. Popham, Educational Statistics: Use and Interpretation (New York: Harper and Row, Publishers, 1967), p. 147.

CHAPTER IV

RESULTS

The results of the present study can be summarized as follows:

1. The high control groups were superior to the low control groups in their problem-solving efficiency (number of questions asked) at the .05 level of significance. Thus, hypothesis number one can be rejected and one can assume that achievement potential was a significant factor in increasing the problem-solving efficiency of high groups over low groups.

2. The high control groups were superior to the low control groups in their speed of problem-solving (number of problems completed) at the .10 level of significance. At this level, hypothesis number two must be accepted and one must conclude that chance could be responsible for the observed mean difference. Even though the null hypothesis must be accepted, this level of significance strongly indicates that achievement potential was a factor in increasing the problem-solving speed of high groups over low groups.

3. Hypothesis number three was not significant. One must accept the null form and conclude that reinforcement had little or no effect on the problem-solving efficiency of the high achievement groups. Any mean difference could be attributed to chance alone.

4. Hypothesis number four was not significant. One must accept the null statement and conclude that reinforcement had little or no effect on the problem-solving speed of the high achievement groups.

5. The low experimental groups were superior to the low control groups in their problem-solving efficiency at the .10 level of significance. At this level, hypothesis number five must be accepted and one must conclude that chance could be responsible for the observed mean difference. However, this level of significance strongly indicates that reinforcement was a factor in increasing the problem-solving efficiency of the low achievement groups.

6. Hypothesis number six was not significant. One must accept the null form and conclude that reinforcement had little or no effect on the problem-solving speed of the low achievement groups.

7. Hypothesis number seven was not significant and one must accept the null statement. Therefore, the observed difference in the problem-solving efficiency between high experimental and low experimental groups can be accounted for by chance alone.

8. The high experimental groups were superior to the low experimental groups in their speed of problem-solving at the .10 level of significance. At this level, hypothesis number eight must be accepted and one must conclude that chance could be responsible for the observed mean difference. Even though the null hypothesis must be accepted, this level of significance strongly indicates that the interaction of both achievement and reinforcement variables was sufficient to increase the problem-solving speed of high groups over low groups.

It can be seen that achievement was the only statistically significant variable with regard to problem-solving efficiency as measured by the number of questions asked. As one would expect, high achievement

groups did significantly better than low achievement groups. When the variable of reinforcement was introduced, the low groups showed a strong tendency (.10 level) to increase in their problem-solving ability, while the high groups showed no significant change. In effect, verbal reinforcement equalized the problem-solving efficiency of the high and low groups with respect to the number of questions asked. The following table will help clarify this point.

TABLE I

CRUCIAL COMPARISONS AMONG THE FOUR MAJOR GROUPS WITH REGARD TO QUESTIONS ASKED*

Group Comparison	Mean Score	Standard Deviation	t	Level of Significance
Low Control	17.33	5.51		
vs.			2.03	.05
High Control	14.19	4.44		
High Control	14.19	4.44		
vs.			-0.32	ns
High Experimental	14.67	5.62		
Low Control	17.33	5.51		
vs.			1.83	.10
Low Experimental	14.52	4.33		
High Experimental	14.67	5.62		
vs.			-0.11	ns
Low Experimental	14.52	4.33		

*All calculations made in this table used an n value of twenty-one (see page 24).

When comparing the speed of problem solving as measured by the number of problems completed, the high achievement groups did not differ significantly from the low achievement groups. When the reinforcement was added, neither high nor low groups showed any significant change. These findings are presented in Table II. The results might have been

TABLE II

CRUCIAL COMPARISONS AMONG THE FOUR MAJOR GROUPS WITH REGARD TO PROBLEMS SOLVED*

Group Comparison	Mean Score	Standard Deviation	t	Level of Significance
Low Control	4.20	1.47		
vs.			-1.93	.10
High Control	6.60	2.06		
High Control	6.60	2.06		
vs.			-0.31	ns
High Experimental	7.00	1.79		
Low Control	4.20	1.47		
vs.			-0.60	ns
Low Experimental	4.80	1.47		
High Experimental	7.00	1.79		
vs.			-1.93	.10
Low Experimental	4.80	1.47		

*All calculations made in this table used an n value of five (see page 29).

significant had a larger n value been used. Since only five subgroups were used, the n value was five. Nevertheless, the effect of verbal reinforcement seemed to present itself in the quality, but not the quantity, of problem solving.

The results of the correlations made between the number of participations and the problem-solving ratios were similar to the t test findings presented in Table I. An initially low correlation for the low achievement group was increased to a marked correlation when the reinforcement was introduced. The high achievement group, on the other hand, showed a marked correlation at first and dropped to a .00 correlation when under conditions of reinforcement. Thus, reinforcement seemed to interfere with the dynamic problem-solving structure of the high groups while strengthening this structure in the low groups.

The reader may note that the negative correlations are to be expected. Obviously, as a group increases in efficiency, it will solve the problems more expediently and thus require fewer total participations. Of concern here is the absolute value of the correlations, and the fact that this value dropped when the high groups were reinforced, but rose when the low groups were reinforced (see Table III, page 30).

TABLE III

PRODUCT MOMENT-CORRELATIONS BETWEEN THE NUMBER OF PARTICIPATIONS AND THE PROBLEM-SOLVING RATIO FOR EACH MAJOR GROUP

Low Control		Low Experimental		High Control		High Experimental	
No. of Partici-pations	Problem-Solving Ratio	No. of Partici-pations	Problem-Solving Ratio	No. of Partici-pations	Problem-Solving Ratio	No. of Partici-pations	Problem-Solving Ratio
218	.040	179	.111	282	.102	172	.133
148	.049	110	.088	149	.089	228	.101
78	.068	254	.078	185	.104	55	.096
204	.080	163	.071	105	.067	154	.122
319	.052	231	.043	47	.281	276	.138
r = -.30		r = -.67		r = -.59		r = .00	

CHAPTER V

SUMMARY AND CONCLUSIONS

I. SUMMARY

The present study assumed that verbal reinforcement of group participation could directly influence a group's problem-solving efficiency. It was further assumed that group reaction to reinforcement is not constant but related to the academic achievement potential of the group. Thus the problem under investigation can be expressed as follows: Does the effect of positive verbal reinforcement influence a high academic achievement group differently from a low academic achievement group with regard to problem-solving efficiency?

The type of problem-solving task chosen for this study relied on two criteria to measure efficiency: the number of information units needed to reach the solution (as measured by questions asked the experimenter) and the speed of performance (as measured by problems solved during the experiment). The criterion for achievement potential was a student's composite ACT score.

The subjects consisted of forty-five high achievement students and forty-five low achievement students enrolled in accelerated and remedial introductory psychology courses at a small midwestern college. From the high population, five experimental (with reinforcement) and five control (without reinforcement) groups were randomly formed. The same procedure was followed for the low population. Each group consisted

of from four to five individuals.

The positive verbal reinforcement consisted of the word "good" pronounced in a flat unemotional tone. This reinforcement was dispensed on a sixty second interval schedule with the requisite that a group member be engaged in a participation act at the moment of presentation. Thus, it was actually a form of group interaction which was being reinforced.

Eight hypotheses were tested using a polled variance t formula. Four of the hypotheses were concerned with comparing the mean number of questions asked, and the other four were concerned with comparing the mean number of problems solved. The basic comparisons were as follows:

1. The high controls' mean was compared to the low controls' mean to determine the effect of achievement potential on group problem solving.

2. The high experimentals' mean was compared to the high controls' mean to determine the effect of reinforcement on the problem-solving efficiency of high achievement groups.

3. The low experimentals' mean was compared to the low controls' mean to determine the effect of reinforcement on the problem-solving efficiency of low achievement groups.

4. The high experimentals' mean was compared to the low experimentals' mean to determine what effect the interaction of achievement potential and reinforcement had on group problem solving.

As a side issue, a product-moment correlation was calculated between the total number of participations made by each subgroup and the group's problem-solving ratio. This ratio was obtained by dividing the number of problems solved by the number of questions asked.

Only one statistically significant result was found. This was that efficiency as measured by the number of questions asked was higher in the high control groups than in the low control groups. Although this was the only statistically interesting result, there were several heuristically interesting results. Under conditions of reinforcement, the low groups showed a strong tendency (.10 level) to increase in their problem-solving efficiency, while the high groups showed no significant change. These findings were more dramatically illustrated when one compared the correlation coefficients. The low groups went from an initially low correlation of -.30 to a marked correlation of -.67 when reinforced. The high groups, however, went from an initially marked correlation of -.59 to a .00 correlation. Both the t tests and the correlations indicate that reinforcement has an interfering effect on the problem-solving dynamics of the high achievement groups.

When comparing the speed of problem solving, there were no statistically significant differences. Furthermore, reinforcement had almost no effect. Thus, verbal reinforcement had a tendency to equalize the quality of problem solving between high and low groups, but had little effect on the quantity of problem solving.

II. CONCLUSIONS

With such meager levels of significance, caution must be used when drawing conclusions. Therefore, this researcher would like to abandon the word conclusions and discuss indications.

Indications are that achievement is a major factor in determining the efficiency of certain group problem-solving endeavors. This is no shock to administrators who have been grouping students on the basis of achievement potential for years. What is of concern is what one does with these students once they have been grouped. Will all students benefit equally from verbal reinforcement regardless of their achievement potentials? The present study indicates that they will not. Low achievement groups show a tendency to increase their quality of problem solving when under conditions of verbal reinforcement, while high achievement groups do not. In fact, reinforcement may even interfere with the high achiever's dynamic problem-solving structure as seen from the correlational data of this study. Other research findings tend to back up these results (see page 16).

As with much research, the major conclusion is that more research needs to be done. This study can offer several suggestions to further researchers in the field. First, since participation holds the key position in this experimental framework, a more reliable method of recording would be appropriate. A tape recorder seems ideal for this purpose. Secondly, there is growing evidence that the experimenter

may easily bias the results in a free-operant situation. Therefore, it would be best if the situation were structured in such a manner that the experimenter was not required to participate. Another alternative would be to keep the researcher "blind" to the experiment. Finally, a somewhat less global approach might prove beneficial. Functional relationships may become apparent when the variables of reinforcement and achievement are studied directly without introducing the concept of group problem solving.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Collins, Barry E., and Harold Guetzkow. A Social Psychology of Group Processes for Decision-Making. New York: John Wiley and Sons, Inc., 1964.

Popham, James W. Educational Statistics: Use and Interpretation. New York: Harper and Row, Publishers, 1967.

Skinner, B. F. Verbal Behavior. New York: Appleton - Century - Crofts, Inc., 1957.

B. PERIODICALS

Barnlund, Dean C. "A Comparative Study of Individual, Majority, and Group Judgment," The Journal of Abnormal and Social Psychology, LII (March, 1956), 219-223.

Bruner, Jerome S. "The Act of Discovery," Harvard Educational Review, XXXI (No. 1, 1961), 21-32.

Douvan, Elizabeth. "Social Status and Success Strivings," The Journal of Abnormal and Social Psychology, LII (March, 1956), 219-223.

Grough, Harrison G. "Factors Relating to the Academic Achievement of High-School Students," The Journal of Educational Psychology, XL (February, 1949), 65-78.

Greenspoon, Joel. "The Reinforcing Effect of Two Spoken Sounds on the Frequency of Two Responses," The American Journal of Psychology, LXVIII (September, 1955), 409-416.

Hildum, Donald C., and Roger W. Brown. "Verbal Reinforcement and Interviewer Bias," The Journal of Abnormal and Social Psychology, LIII (July, 1956), 108-111.

Marlowe, David. "Need for Social Approval and the Operant Conditioning of Meaningful Verbal Behavior," Journal of Consulting Psychology, XXVI (No. 1, 1962), 79-83.

Ray, Wilbert S. "Complex Tasks for Use in Human Problem-Solving Research," Psychological Bulletin, LII (March, 1955), 134-149.

Rosenthal, Robert. "Covert Communication in the Psychological Experiment," Psychological Bulletin, LXVII (May, 1967), 356-367.

Sarason, Irwin G. "Interrelationships Among Individual Difference Variables, Behavior in Psychotherapy, and Verbal Conditioning," The Journal of Abnormal and Social Psychology, LVI (May, 1958), 339-344.

Sarbin, Theodore R., and Vernon L. Allen. "Increasing Participation in A Natural Group Setting: A Preliminary Report," The Psychological Record, XVIII (January, 1968), 1-7.

Staats, Arthur W. "Verbal and Instrumental Response-Hierarchies and Their Relationship to Problem-Solving," The American Journal of Psychology, LXX (September, 1957), 442-446.

Taylor, Donald W., and William L. Faust. "Twenty Questions: Efficiency in Problem Solving as a Function of Size of Group," Journal of Experimental Psychology, XLIV (November, 1952), 360-368.

Verplanck, William S. "The Control of the Content of Conversation: Reinforcement of Statements of Opinion," The Journal of Abnormal and Social Psychology, LI (November, 1955), 668-676.

Zigler, Edward, and Paul Kanzer. "The Effectiveness of Two Classes of Verbal Reinforcers on the Performance of Middle- and Lower-Class Children," Journal of Personality, XXX (June, 1962), 157-163.

C. PUBLICATIONS OF THE GOVERNMENT AND OTHER ORGANIZATIONS

American College Testing Program. Using ACT on the Campus '68 - '69. Iowa City: American College Testing Program, Inc., 1968.

Pierce, James V., and Paul H. Bowman. "Motivation Patterns of Superior High School Students," The Gifted Student. Cooperative Research Monograph No. 2. Washington: U. S. Government Printing Office, 1962. pp. 33-66.

APPENDIX A

INSTRUCTIONS

You are about to participate in an experiment in group problem-solving. You will receive a score based on your performance as a group and not as individuals. Therefore, it is important that you talk among yourselves and cooperate as much as possible in reaching your solutions.

I will have in mind an object which should be familiar to all of you. Your task will be to discuss among yourselves, and decide the best questions to ask me in order to guess the object. The questions must be worded so that I can answer them with "yes," "no," "sometimes," or "partly." The group's job will be not only to use the fewest number of questions possible, but also to guess as many objects as possible within the thirty minute test period. Therefore, it is important to choose your questions wisely without spending too much time on any one object. If the item has not been guessed within twenty-five questions, I will tell you, and we will start on the next object.

Each of you will take turns asking me the question the group has decided upon. The first person to my left will ask the first question, the person to his left will ask the next question, and so on, always rotating in a clockwise manner after each question. I cannot answer until the proper spokesman has formally asked me the question.

Since you will be compared with other members of your class, it is important that you do not discuss the experiment with them. I will be recording a number of things, so please do not let me distract you from your task. Are there any points you are not clear about?

Keep the following things in mind:

1. You should cooperate and share your ideas with the other members of your group.

2. You should ask me as few questions as possible when trying to guess the objects. However, you should work as quickly as you can, because you also want to find as many objects as possible in the thirty minute test period.

3. The spokesman should word the group's question so that I can answer it with "yes," "no," "sometimes," or "partly."

4. You should not damage your group's score by discussing the experiment with other class members.

APPENDIX B

FINAL PROBLEM LISTS AS DETERMINED
BY THE LATIN SQUARE MODEL

List Number	Level of Difficulty*									
1	Chicken (1)	Socks (5)	Bean (4)	Cadillac (3)	Oak (2)	Rose (1)	Kennedy (5)	Airplane (4)	Emerald (3)	Penny (2)
2	Pig (2)	Coat (1)	Pea (5)	Dodge (4)	Walnut (3)	Mum (2)	Washington (1)	Motorcycle (5)	Diamond (4)	Dime (3)
3	Horse (3)	Dress (2)	Carrots (1)	Pontiac (5)	Maple (4)	Daisy (3)	Lincoln (2)	Bus (1)	Jade (5)	Half Dollar (4)
4	Cow (4)	Slacks (3)	Potato (2)	Ford (1)	Pine (5)	Carnation (4)	Johnson (3)	Train (2)	Ruby (1)	Quarter (5)
5	Sheep (5)	Shirt (4)	Corn (3)	Chevrolet (2)	Elm (1)	Orchid (5)	Nixon (4)	Ship (3)	Sapphire (2)	Nickel (1)

*Number one (1) stands for the least difficult item in a given category, while number five (5) stands for the most difficult.

APPENDIX C

TEN GENERAL CATEGORIES USED IN DETERMINING
THE FINAL PROBLEM LISTS

1. Barnyard Animals
2. Articles of Clothing
3. Vegetables
4. Makes of Cars
5. Trees
6. Flowers
7. Presidents
8. Transportation Vehicles
9. Precious Stones
10. American Coins