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HOMOGENEITY OF MEMBER PERSONALITY AND
ITS EFFECT ON GROUP PROBLEM-SOLVING

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Psychologists have only recently begun to show an interest in the relationships between the structure of groups and their problem-solving effectiveness. Rosenberg, Erlick, and Berkowitz (9) have demonstrated an "assembly effect" in the group product, an effect based not on the characteristics of each person, but on the relations of the characteristics of each individual to those of the others in the group. Schutz (10) showed that the performances of "compatible" groups were superior to those of "incompatible" groups on two tasks.

In these studies, as in most problem-solving experiments, the nature of the tasks used was undefined. Certain questions remain unanswered: Will an "assembly effect" be seen on all tasks? Will "compatible" groups be superior on every type of problem?

The present experiment examined the interrelationships among different group structures and different task characteristics, as these interrelationships determined the "quality" and "acceptance" of the group product (6). The groups varied in the degree of similarity or homogeneity of their members' personalities. The effects of these variations were examined in terms of the quality and acceptance of solutions to two different problems. One problem involved quality alone; the other involved acceptance and quality.

Development of Hypotheses

Both Maier (5) and Duncker (1) have emphasized the importance of the "direction" or initial orientation toward a problem in the problem-solving behaviors of individuals. Maier presented evidence that a person who has many "directions" available, i.e., is capable of many restructurings of his perceptual field, is more likely to be a successful solver than the person who is inflexible and adheres to a single direction.

On the assumption that "direction" operates in the same way in groups as in individuals, the variety of possible directions available from the members of the non-homogeneous groups, deriving from their varied perceptual and cognitive structures, should yield higher quality solutions in these groups than in homogeneous groups. The higher quality solutions should result from the many different ideas and from the emphasis placed on different aspects of a problem by the members of non-homogeneous groups. This conclusion should be true only for those tasks requiring multiple perceptions and cognitive reorganizations for their solution. Hypothesis I states therefore:

On the problem involving quality alone, non-homogeneous groups produce higher quality solutions than do homogeneous groups.

The nature of non-homogeneous groups implies differences in affective structures -- in the inner-personal regions -- as well as in cognitive structures among the group members. When a problem has no objectively good solution -- i.e., when the quality of the solution can

be judged only in terms of the members' personal values and standards -- then differences in affective structures in non-homogeneous groups should again produce conflict. The result of such conflict is difficult to predict. If the values involved are not central to the members of the group there is a high probability of affective restructuring and easy resolution of the conflict. The group is likely to generate a unique and interesting solution. If the issues are more central, affective restructuring is less likely to occur, and the non-homogeneous group is more likely to fail to agree on a solution. The status quo situation will continue. Problems requiring affective restructuring are considered to be acceptance problems. To the extent that a problem involves both quality and acceptance, successful solutions will require changes in both cognitive and affective structures of the group members. Hypothesis II states:

On the problem involving quality and acceptance, non-homogeneous groups either fail to agree on a solution and resist change, or produce inventive solutions.

Homogeneous groups produce few inventive solutions, but either fail to agree or accept an alternative solution offered to them.

Hypothesis III, concerning satisfaction with the solutions, also derives from the preceding considerations. We may assume that a solution is acceptable to a person to the extent that it satisfies his needs in the situation, and that in a problem-solving situation a good solution would satisfy certain of his needs. If he then perceives that the best suggestions made by the members are incorporated in the group's

solution, he will be satisfied with the solution. In the homogeneous groups, approval should be almost unanimous. The solutions although incorporating only a limited number of ideas, represent the opinions of all the group members, since these would tend to be similar. In non-homogeneous groups, however, unanimous satisfaction should be found only in those groups with high-quality solutions, where the multitude of ideas produced have been used in the solution. Based on these deductions, Hypothesis III states:

For homogeneous groups there is no relationship between the degree of satisfaction with the solutions and their quality for either type of problem. For non-homogeneous groups there is a positive relation between the degree of satisfaction with and the quality of the solutions.

Design of the Study

The experimental procedure was conducted twice, once in the spring semester and again in the fall semester of 1955. The subjects were sophomore, junior and senior students in the undergraduate course, Psychology of Human Relations. The 175 students were assigned to seven laboratory sections of about 25 students each. In laboratory sessions the students participated in a case discussion or role-playing situation each week to learn skills in interviewing and in group leadership.

The Guilford-Zimmerman Temperament Survey (GZTS) was administered as the personality measure at the beginning of each semester to all students (2). Although the GZTS was developed to measure personality traits and not tension systems in people, it was selected as the personality measure for its reliability and for the relative independence of

its dimensions (2). It was assumed that these ten traits were a sample of the personality characteristics of the respondents and that therefore people with similar profiles probably have more similar personalities than those with dissimilar profiles. Kendall's Tau was used to determine the correlation between the ten-score profiles of every pair of students in each laboratory section. Approximately two thousand correlations were computed each semester for the seven laboratory sections. With the aid of the Michigan Digital Automatic Computer (MIDAC) these computations were made in sufficient time to establish the groups by the following week's meeting.¹

The reliability of the profile correlations was computed by a split-half technique on a sample of 50 students. Corrected Spearman rank-order correlation coefficients between odd and even halves of the GZTS had a median of .77. Thirty-seven of the 50 coefficients equaled or exceeded .64, the value needed for significance at the .05 level of confidence.

Three types of four-person groups were assembled in the following way: (a) Type 1 groups (homogeneous) were composed of persons with high positive taus; (b) Type 2 groups were composed of persons with both high negative and high positive profile correlations; and (c) Type 3 groups consisted of persons whose taus were approximately .00. The number of groups of each type initially established were respectively 20, 15, and 22 for a total of 57 groups. A comparison of the algebraic and absolute sums of tau for the three types of groups provided statistical evidence that there were distinct qualitative differences in the personality mixtures of each group type. The homogeneous groups, moreover,

represented such different dominant personality patterns that a subsequent attempt to analyze possible differences among groups of this type had to be abandoned for lack of a sufficient number of groups of any one personality type. Although students were assigned to these different types of groups purely on the basis of their personality characteristics, comparisons of the various types of groups also indicated no differences in the sex composition (the mixture of males and females) and in the mean final course grade.

The solutions to two problems and measures of satisfaction with these solutions served as the dependent measures. The first of these problems -- one involving quality alone -- was the Mined Road Problem (MRP)². It was administered in both semesters in the next to the last meeting of the semester.

On this problem the group is told that it is a five-man guerilla team which has just blown up an enemy bridge and is attempting to return to its own lines. In order to meet a truck which is to carry the group back to the base, the men must cross a road which is known to be heavily mined. Scattered around the area are some scrap materials, e.g., ropes, lumber, etc., which could be used to cross the road. The problem is to determine the best method for crossing the road safely, quickly, and without leaving traces of the crossing.

Solutions to the problem were assigned a numerical score based on a content analysis scheme developed by Lorge and his associates (8). A solution accumulated points according to the relative feasibility of the method used to cross the road, the relative safety, the concealment

of clues, and the time taken to solve the problem.

The reliability of the scoring system was computed by a repeat scoring of a sample of nineteen group solutions two weeks after the initial scoring. The correlation between these two sets of scores was .84, high enough to give us confidence in the results obtained from the use of the scoring system.

The second problem was the Change of Work Procedure (CWP) problem developed by Maier for use in training supervisors in human relations practices (6, p.54). The problem was considered primarily an affective problem with a high "acceptance" component to it (6). That is, although solutions to the problem can be classified into different types, there is no objectively "best" solution -- the best one being that solution which is most acceptable to the group and which they will be willing to carry out. Because we can consider certain solutions to be inventive, however, the problem also has a quality component.

The problem is a role-playing situation in which three workers, who perform three different jobs in hourly rotation with each other, report to a supervisor, the fourth man in the group. The supervisor, at the suggestion of a time-study man, requests the group to work fixed positions instead of rotating their jobs, to achieve more efficient production. Solutions to the problem resolve the conflict between attempts to capitalize on individual ability for higher production (supervisor's suggestion) and the freedom from monotony resulting from rotation.

Three types of solutions are usually obtained: (a) Old solutions -- the group refuses to change or continues rotation with a different time interval between changes; (b) New solutions -- complete acceptance of the supervisor's suggestion or acceptance with some minor modifications like rest pauses or music; and (c) Compromise or Inventive solutions -- work procedures which were not included in the roles themselves but which are attempts to gain the advantages of both individual ability and freedom from monotony. Assignment of the solutions obtained in this study to these categories offered no difficulty. A reclassification of the solutions after a two-week interval showed almost perfect agreement with the initial classification. The scorings of both MRP and CWP were done without knowledge of what type group had submitted the solution.

For both problems measures of the satisfaction with the solution reached by the group were collected. For the MRP, the question took the form, "Were you satisfied with: (a) the entire solution,...(d) practically none of the solution?" For the CWP students were asked, "How satisfied are you with the solution reached by the group? (a) very satisfied,... (e) very dissatisfied."

The problem-solving activity, the collection of solutions, and the expressions of satisfaction with the solutions were part of the usual classroom procedure. The experimental procedure introduced written solutions and written expressions of satisfaction instead of the usual oral collection of these data.

Results

The results of the problem-solving sessions will be discussed first in terms of the quality and the kinds of solutions obtained in the

two groups, and second in terms of the acceptance of the solutions by the groups.

When the MRP was administered only four Type 2 groups were wholly intact. These four were combined with the thirteen intact Type 3 groups to form seventeen non-homogeneous groups for the analysis. To test Hypothesis I, the scores for these groups have been compared with the scores of the thirteen intact Type I (homogeneous) groups in Table 1.⁵

Table 1

Comparison of Scores on Mined Road Problem

<u>Group Type</u>	<u>Tau</u>	<u>Mean*</u>	<u>Standard Deviation</u>	<u>Number of Groups</u>
Type 1 (Homog.)	+	44.5	28.63	13
Non-Homogeneous	0, -	63.1	28.53	17

* t-test that the Mean of Non-Homogeneous groups is greater than the Mean of the Homogeneous groups is significant at the .05 level of confidence.

The higher the score the better is the solution. The 18.6 point superiority of the mean of the non-homogeneous groups over that of the homogeneous groups supports Hypothesis I. The difference is statistically significant at the .05 level of confidence using a one-tailed t-test. The superiority of the non-homogeneous groups is even more apparent when the two distributions are compared. When the results of all the groups were combined, only three (23%) of the thirteen homogeneous groups exceeded the median score for the total distribution, whereas twelve (71%) of the seventeen non-homogeneous groups surpassed that score.

Although the groups were assembled purely on the basis of the degree of homogeneity of the members' personalities, the question may be raised as to whether the obtained differences can be safely attributed to the personality differences alone. Three other variables which could have accounted for the differences were examined: (1) intelligence and knowledge of the subject matter of the course, as measured by the final course grades, (2) the sex composition of the group -- the number of women in the group, and (3) the sociometric attractiveness of the group. No significant differences were found to distinguish among the groups, thus reinforcing the causal link between the personality composition of the groups and their problem-solving qualities.

The results for the CWP were less clear-cut. The distributions of solutions for the homogeneous and non-homogeneous groups are presented in Table 2. The chi-square value for the contingency table comparing the homogeneous and non-homogeneous groups is 2.88, which is not significant at the .05 level of confidence. Hypothesis II was therefore not confirmed. Both homogeneous and non-homogeneous groups tended to accept the supervisors's suggested work method, the New solution.

Table 2

Number of Groups Producing Each Type of Solution

<u>Group Type</u>	<u>Tau</u>	<u>N</u>	<u>Type of Solution</u>		
			<u>Old</u>	<u>New</u>	<u>Inventive</u>
Type 1 (Homog.)	+	12	4	6	2
Non-Homogeneous	0, -	17	2	8	7

Considering Inventive solutions alone, however, we find that only two (16%) of the twelve homogeneous groups as against seven (41%) of the seventeen non-homogeneous groups produced such solutions. Although

the percentage difference is not statistically significant, it suggests that the resolution of conflict generated in certain non-homogeneous groups resulted in ideational creativity.

The data reflect a high degree of satisfaction with the solutions to the MRP in both types of groups, despite the fact that the solutions to the problem produced by the homogeneous groups were so inferior by the objective criterion. In 21 of the 30 groups all four people agreed with the final group solution. The tendency toward group acceptance of the solution was especially marked in the homogeneous groups, where the mean number satisfied was 3.8 out of a possible 4.0, and where only 2 of the 13 groups were not completely in accord on the final solution. In the non-homogeneous groups, the mean was 3.3 and 7 of the 17 groups were not unanimously satisfied.

The data support the first part of Hypothesis III, which predicted no relationship between the quality of the solution and the degree of satisfaction with the solution in the homogeneous groups. Where there is no variance there can be no relation. Almost every homogeneous group was satisfied with the eminently poor solutions they achieved.

However, in the non-homogeneous groups satisfaction was not related to the quality of the solution either. When the distribution of scores on the MRP was dichotomized at the median, and the non-homogeneous groups whose members were completely satisfied were compared with those where satisfaction was less than unanimous, no relationship was found between the quality of and satisfaction with the solution. The expectation that members of non-homogeneous groups would be less satisfied with a poor solution than with a good one was not confirmed by the data.

Hypothesis III was not confirmed by the data for the CWP either. The relationships within each group type, although in the positive direction, are not statistically different from each other nor are they significantly different from zero. For both types of groups, where the group generated the Inventive solution, the members of the group were unanimously satisfied with the solution (Table 3). In the one group which produced an Inventive solution but where satisfaction was less than unanimous, three of the four members were satisfied. The relationship for the combined groups is significant at the .05 level of confidence. If a group succeeded, on this problem of quality and acceptance, in generating a solution which encompassed both problem aspects of the situation -- i.e., obtaining greater productivity without monotony and boredom -- the group members accepted the solution as satisfactory.

The results of this study support the value of studying the effects of the structure of groups without regard to the particular characteristics of the individuals in the groups. An important determinant of the group's effectiveness is the interaction of these individual characteristics. The degree of homogeneity of personality of the members of the groups used in this study was seen to have a direct bearing on the effectiveness of the groups in producing solutions to problems.

Homogeneity as operationalized here was a relatively pure concept. It concerned the degree of similarity of the personality types comprising the group membership, rather than the particular personality types of the individuals in the groups. The members of different homogeneous groups were not interchangeable, and the personality types which were dominant in the homogeneous groups varied from group to group. The members of the

Table 3

Relation Between Type of Solution and
Satisfaction with the Solution

(Change of Work Procedure)

Homogeneous

<u>Number Satisfied</u>	<u>Type of Solution</u>	
	<u>Old or New</u>	<u>Inventive</u>
Four	3	2
Less than Four	7	0
		p = .15

Non-Homogeneous

<u>Number Satisfied</u>	<u>Type of Solution</u>	
	<u>Old or New</u>	<u>Inventive</u>
Four	6	6
Less than Four	4	1
		p = .24

Total

<u>Number Satisfied</u>	<u>Type of Solution</u>	
	<u>Old or New</u>	<u>Inventive</u>
Four	9	8
Less than Four	11	1
		p = .03

non-homogeneous groups obviously varied considerably in the types of personalities they represented. The relative "pureness" of the concept of homogeneity makes all the more impressive the finding that the non-homogeneous groups did significantly better on the MRP than did the homogeneous groups, and that there was a tendency for the non-homogeneous groups to produce more inventive solutions on the CWP.

The results imply that a multiplicity of perceptions of a problem are productive of creative solutions. In the present trend towards group research in scientific organizations and toward group decision-making in various administrative circles, the abilities of each individual may be less important than the peculiar composition of backgrounds and experiences represented by the various members of the team. Pelz, in a study of a scientific research organization (7), found that frequent contact between a scientist and other members of his research group was related to the scientist's own productivity only in those situations where the other members of the group were dissimilar from him in their work motivations and previous work experience. Pelz's findings suggest that the results reported in the present study are probably generalizable well beyond the limited population of college students who supplied the data.

The findings with respect to satisfaction of the group members with the solution to problems also bear comment at this point. On the MRP there was a high degree of satisfaction with the solutions obtained in almost every group regardless of type. Even in those non-homogeneous groups in which unanimous satisfaction was not achieved, only one or two members in each group were not completely satisfied with the solution. On the CWP, however, the only groups which showed a similar unanimous

satisfaction with the solution were those which produced inventive solutions. These two sets of results suggest the possible fruitfulness of a distinction between decision-making, in which the group members choose among one of several alternatives, and problem-solving, in which the members work through a problem and create a solution. The majority of solutions to the CWP were Old or New solutions, the results of choosing between alternative solutions already given in the problem situation. The creation of inventive solutions to the CWP and of all solutions to the MRP required the groups to combine elements and develop new procedures. For the college student group in this study the creative process was a more satisfying experience than the decision-making one.

A final important consideration emphasized by the results of this study is the lack of adequate classification of problem-solving tasks in the psychological literature. An attempt was made to classify the two problems in this study on an a priori basis according to the cognitive or quality aspects versus the affective or acceptance aspects of the problem. The MRP was considered to be purely a quality problem requiring the group members to reorganize their cognitive fields in a way which would provide solutions to the problem. The CWP was considered to be a problem involving both quality and acceptance. The hypotheses concerning differences between the performances of homogeneous and non-homogeneous groups rested on the assumed validity of these classifications. The lack of support for the hypothesis concerning solutions to the CWP (Hypothesis II) may have been a refutation of the theory or possibly only of the validity of the problem description.

Ray (8) recently performed a service for psychologists by bringing together the variety of problems frequently used in research on the problem-solving process. The lack of any apparently common elements in these tasks points up the problem of predicting group performance knowing only the nature of the group. The interrelationships among group and task characteristics are fundamental, and the study of group problem-solving cannot afford to ignore them.

Summary

The study investigated the relationships between the characteristics of groups and of problem-solving tasks, and the effects of these relationships on the groups' problem-solving performances. The performances of groups varying in the homogeneity of their members' personalities were compared on a problem involving quality alone, and on another involving acceptance and quality.

On the basis of correlations between pairs of profiles of scores on the Guilford-Zimmerman Temperament Survey, groups of four students each were established at the beginning of two semesters in a course in human relations. Homogeneous groups, in which the members had high positive profile correlations, and non-homogeneous groups, in which the profile correlations were zero or negative, were maintained throughout each of the semesters.

The non-homogeneous groups produced significantly superior solutions to the quality problem, and showed a tendency to produce more inventive solutions to the problem involving quality and acceptance. No significant differences were found in the degree of satisfaction with solutions to either of the problems. On the problem of quality and

acceptance, a significant correlation was found in both types of groups between the members' satisfaction with the solution to the problem and the quality of the solution.

FOOTNOTES

1. The author thanks his wife, Roslyn B. Hoffman, for programming the computation of tau for the MIDAC and Drs. John W. Carr, III and Cecil Craig representing the Rackham School of Graduate Studies for allowing me to use the MIDAC and for providing funds to pay for the computer time required. Without this assistance the magnitude of the computations involved would have made this study impossible to do within the limited time available.
2. I wish to thank Professor Irving Lorge of Columbia University for supplying me with copies of the Mined Road Problem and the scoring key and for discussing the interpretation of the scoring procedure with me.
3. The data for both problems are based on the products of only those groups which were wholly intact -- i.e., all four members were present -- at the time the problem was administered to the class. The use of only intact groups for the analysis attempted to avoid bias due to differences in group size, and to any non-random forces which might be operating to cause a person to be missing (e.g. rejection by or of the group) and to make the intact parts of these groups different from the wholly intact groups. Sixty-five per cent and sixty per cent of the homogeneous groups were intact for the MRP and the CWP respectively. Forty-six per cent of the combined non-homogeneous groups were present for both problems. This percentage difference is not statistically significant. A significantly smaller percentage (27%) of the Type 2 than Type 1 groups was intact for the MRP.

REFERENCES

1. Duncker, K. On problem-solving. Psychol. Monogr., 1945, 58, No. 5 (Whole No. 270).
2. Guilford, J. P., and Zimmerman, W. S. The Guilford-Zimmerman Temperament Survey. Beverly Hills: Sheridan Supply Co., 1949.
3. Hoffman, L. R., Homogeneity of member personality and its effect on group problem-solving. Unpublished doctor's dissertation, University of Michigan, 1957.
4. Lorge, I., Tuckman, J., Aikman, L., Spiegel, J., and Moss, G. Solutions by teams and by individuals to a field problem at different levels of reality. J. Educ. Psychol., 1955, 46, 17-24.
5. Maier, N.R.F. Reasoning in humans. I. On direction. J. Comp., Psychol., 1930, 10, 115-144.
6. Maier, N.R.F. Principles of human relations. New York: Wiley, 1952.
7. Pelz, D. C. Some social factors related to performance in a research organization. Administrative Sci. Quart., 1956, 1, 310-325
8. Ray, W. S. Complex tasks for use in human problem-solving research. Psychol. Bull., 1955, 52, 134-149.
9. Rosenberg, S., Erlick, D. E. and Berkowitz, L. Some effects of varying combinations of group members on group performance measures and leadership behaviors. J. abnorm. soc. Psychol., 1955, 51, 194-203.
10. Schutz, W. C. What makes groups productive? Hum. Relat., 1955, 8, 429-466.

