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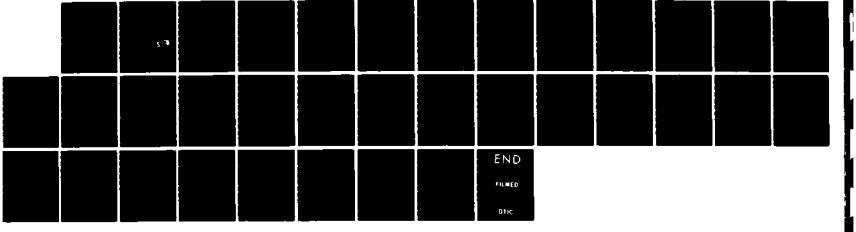

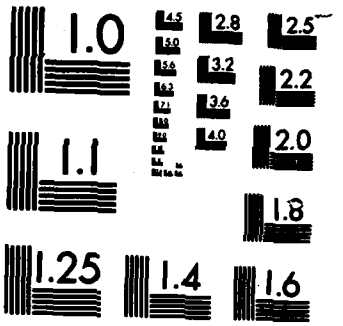

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This study investigated the effects of group composition and evaluation instructions on a motor task, a creative-cognitive task and a cognitive decision-making task. An anonymous group technique was used to control for extraneous variables that are frequently present in small group studies. The subjects were 48 females from undergraduate courses at the University of Hawaii. A 2 X 4 (composition X instruction) ANOVA was computed for performance on each of the tasks. A significant main effect for group, showing

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Perceived Heterogeneity and its Effects on Various Types of Tasks

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less than

Abstract

This study investigated the effects of group composition and evaluation instructions on a motor task, a creative-cognitive task and a cognitive decision- making task. An anonymous group technique was used to control for extraneous variables that are frequently present in small group studies. The subjects were 48 females from undergraduate courses at the University of Hawaii. A 2 X 4(composition X instruction) ANOVA was computed for performance on each of the tasks. A significant main effect for group, showing improvement under perceived heterogeneous affiliation, was found using the creative cognitive dependent variable($p < .05$). Significant group X instruction interactions were found for the cognitive decision-making task($p < .02$) and the motor task($p < .04$). These findings are addressed in terms of factors inherent in the composition of the groups and nature of the tasks. Implications for future research are outlined and discussed.

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Perceived Heterogeneity and its Effects on Various Types of Tasks

It is a well-established fact that most of today's real-world tasks and problems require expertise rarely possessed by a single individual (Spekke, 1975; Toffler, 1980; Naisbitt, 1984). Complicated "brain teaser" problems are solved more quickly and creatively by groups of cognitively heterogeneous persons. Scientific research is more productive when conducted by scientists with some divergence of opinion as to methods and means (Pelz & Andrews, 1976). On another level, homogeneous gene pools among plants and animals are not very adaptable to changing environmental conditions. While there are tasks and environments where homogeneous groups outperform heterogeneous groups (Ziller, 1976), we believe that the existence of a diverse population (age, ethnicity, gender, cognitive styles, personality differences, etc) combined with the existence of complex real-world problems should motivate scientists to learn more about the determinants of effective performance by heterogeneous groups on various tasks. This investigation is part of a series of studies along this theme.

Most of the research in group productivity has focused on two separate variables: the composition of the group in terms of gender, ethnicity, age,or personality (Gurnee, 1937; Heslin,1969; Pelz & Andrews, 1976; Hoffman & Bethouski, 1981; Osato, Campos, Goodman, & Landis, 1983), and the nature of the task(Kent & McGarth, 1969; Mcinturff, Campos, Irving, & Landis, 1983;

Pepinsky, Pepinsky & Pavlik, 1960). It has been well documented that heterogeneous groups outperform corresponding homogeneous groups on a variety of tasks(Ziller, 1976; Hoffman & Maier, 1961). Generally, efforts to assess and predict performance on different tasks have not been conclusive(Freedman, Klevansky & Ehrlich, 1971; Lord, 1976). None of these studies have empirically examined task interaction effects.

Previous studies have entailed assembling the subjects into groups prior to the implementation of instructions, so that the groups can cooperate on the task at hand. Although this may appear to be the most direct application of the task and extraction of the data, it is hardly the most convenient in terms of scheduling, space requirements, and control of ideosynchratic noise that may bias performance in some of the groups.

The present study attempted to control for extraneous noise variables by running subjects individually, yet informing participants that their results would be included in a larger group. This anonymous group technique met with success in an earlier investigation(Schacter, Ellerston, McBride, & Gregory, 1951). Half of our subjects were informed they were part of a heterogeneous group, whereas the other half were instructed that their scores would be included with a homogeneous group. Each subject completed three tasks: a difficult cognitive-decision making task(MAP GAME), a simple behavioral motor task(construction of symbols), and a simple creative-cognitive task(WORD GAME). This provided an empirical measure of task X group composition interaction. The tasks within this paradigm

meet Steiner's (1972) standards for being termed unitary tasks(i.e. tasks that cannot logically permit division of labor among group members). In a maximizing situation(where a premium is put on speed of completion) Steiner goes on to say that final group production can be affected by the prevailing evaluation criteria. Four types of criteria: disjunctive, conjunctive, additive, and discrepant were explicated in instructions given to the members of each group. This manipulation permits differential effects on task performance to be assessed. Females with similar backgrounds(Hawaii residents of oriental extraction) were chosen so that any influences due to culture and sex could be controlled for.

A major purpose of this study was to determine if this simpler paradigm could result in similar heterogeneous/homogeneous group differences found in previous studies. Secondly, the above mentioned variables(group composition, task difficulty and perceptions regarding evaluation criteria) have only been studied in single design research. Unstudied as yet is how group productivity is affected by the interactions among these variables.

Method and Procedure

Subjects: Forty-eight females enrolled in undergraduate psychology courses at the University of Hawai'i participated in exchange for course credit. Subject characteristics--including age, ethnic background, percent of friends with similar ethnic background, paternal lineage and maternal lineage--were

distributed equally across cells. Ages ranged from 17 to 38(Median=21), with 66% in the range of 18-22. Seventy-one percent of the subjects were of Japanese-American background or other oriental groups. This distribution ratio approximates the make-up of the Hawaiian population(65% orientals) based on 1980 census figures. Seventy-one percent of the subjects reported that at least 50% of their friends were from similar ethnic backgrounds. Paternal family lines reflecting uniform heritage went back at least as far as 'grandfather' for 77% of the subjects. Corresponding maternal lineage went back at least as far as 'grandmother' for 71% of the subjects.

Dependent variables;: There were three types of tasks: behavioral, creative-cognitive, and cognitive decision- making. The behavioral task had three different elements: tracing, cutting, and shading paper shapes. The materials were a cardboard stencil in the form of a five-pointed star, large sheets of white paper, and drawing pencils for the tracing task; sheets of paper printed with stars and large scissors for the cutting task; and a variety of ready-cut geometrical shapes to be shaded with pencils according to a visually-presented key: stars to be shaded solid, triangles striped and diamonds cross-hatched. The score was the numbers of items completed in the alloted time.

The second type of task, creative-cognitive, consisted of a simple and familar word-game in which the subject is required to form words out of the letters of a given word. Three words ("revolutions", "established", and "contemplate") were used with scores being the number of accepted (found in Webster's

Dictionary) words produced in the alloted time.

The third type of task was more complex task and required the manimpulation of cognitive elements in a decision-making task (Landis and Slivka, 1972 review a number of studies using this task). Subjects were asked to put themselves in the role of a reconnaissance pilot overflying territory vital to an enemy. The aim of the task is to plan a route across the map provided which maximizes profits--represented by variables denoting population size and strategic value of the cities--while minimizing losses--represented by the probability of losing the aircraft to enemy fire, and the probability of finding the enemy in a given city. Subjects had to bear these four variables in mind when planning their routes, and were required to perform some rapid arithmatic calculations to assess the value of the reconnoitered cities in order to achieve a high score. In addition they had to contend with two other requirements: a compulsory return to home base and a penalty for flying over the same city twice. The materials were three schematic maps, each with its own explanatory key, and flight plan sheets for recording the details of their routes. Scores were computed by a formula incorporating both positive and negative factors, and yielding a single numerical value per city. Each subject's average score (sum of city values over the number of cities) was taken in order to normalize the effects of differing strategies. Subjects were given 5-min for each subtask and timed to one-second accuracy.

Independent variables: Subjects were randomly assigned to one of eight groups or cells according to combinations of levels of the two independent variables: type of group and type of

instructions. By "group" we mean whether or not the subject was lead to believe that the others in her group were "just like her" or "very different from her". "Level of instruction" refers to the way in which the pay-offs for the "group" performance was to be computed. The four levels of this variable come from Steiner's (1972) conceptualization: Disjunctive, conjunctive, additive, and discrepant. The specific ways in which these variables were defined to the subject are given below.

Procedure: Subjects were recruited through the undergraduate psychology subject pool as well as by direct appeals in Psychology classes. Prior to being called to participate, each subject completed a lengthy questionaire providing information about demographic, personality, and cultural-attitudinal factors. The sessions were held in a quiet room at the University or in an off campus research building. Each subject was tested individually with sessions lasting from 1 1/4 to 1 1/2 hours.

At the start of the session, the experimenter introduced herself, and briefly explained the purpose of the study. In order to set-up the manipulations, the experimenter read the following instructions:

> You are helping us to study the effectiveness of group-problem solving in what we call an anonymous group. This means that none of your group members will ever actually see or directly communicate with the others. Instead, an experimenter will act as a go-between whenever there is a need for communication between you. The purpose of the study is to examine the effects of operating under just those conditions. We think the results could have far-reaching consequences in the real world. More and more, computerization and specialization of work is leading to the creation of this kind of work group in real life. Decisions are made by the

group without direct or personal contact ever being made between the members of the group. Air traffic control is a good example and military surveillance and computerization in corporations are other areas where our results may be relevant.

To examine the effects of working in this anonymous group setting thoroughly, we have devised three specific duties in three different types of tasks. One task involves the production of paper symbols. You will be asked to trace around a stencil, cut out shapes, or shade them in. Speed is important here because your score will be the number of shapes you can finish in the five minutes I will give you for each job. The other two types of tasks are problem-solving games. In one, you will be given a long word and your task is to make up as many words as you can out of its letters. Again, you need to work quickly because your score will be the number of words you can make up in five minutes. The last task is the most complicated of the three. It is a map game. You have to put yourself in the role of a military strategist, planning to fly a plane over enemy territory to reconnoiter the area. You have to select a route that will give you a high score while trying to avoid some of the dangers, like losing your valuable plane to the enemy. The rules are rather complex, so we'll go over it all in detail when we come to it.

In order to give your group a good chance of performing well on these tasks, we have made certain that all of the members of your group are:

homogeneous group: " carefully matched on all the relevant variables which we could extract from the questionaires that you filled out before, so that you will all be compatible and close on all the things that could affect your performance"

heterogeneous group: " completely randomly selected for all the different people here and on the mainland who completed those questionaires, so that we don't have any bias from having only one type of person in each group"

We have done this very carefully and we have every reason to believe that your group is ("a really well-matched group of similar people" or "a totally random sample group") and from what other people have found in their experiments in this area, it seems that this is the kind of group that scores really well and works really well together.

I will be giving you an envelope containing the test materials. It will have one of the duties for each type of taks, so altogether you will be given three different envelopes today. That makes nine separate tasks. Each subject in your group will be doing the same sort of task, but in a counterbalanced order, and at a different time.

Manipulation of payoff beliefs: Subjects were given one of the following instructions:

To determine the group's final score, we will

Disjunctive: take the best score of the three foreach subtask. This way we use the top scoring individual to represent the whole group and maximize an excellent performance by any one member.

conjunctive: take the lowest score of three for each subtask. This is a reflection of the way things are in real life: a group is only as good as its weakest member.

additive: add together the scores of all three group memberson each subtask. This way each member is given an equal weight in measuring the group's performance.

discrepant: contact all the group members when all the results are in and ask for their views on the most profitable way to use the individual scores in making up a group total. There are several options: you could chose the highest of the three scores on each subtask to represent the group's total, taking advantage of an excellent performance by any one of the individual members. Or, you could take the average of the three scores and even out any difference. You could add the score together and achieve the same result, or you could weight the scores so that highest has a weight of three, the next a weight of two, and the lowest a weight of one, thus maximizing the highest score and minimizing the lowest ones. It will be up to you and your fellow group members to decide, but, of course you won't be asked to do that until all the data are in.

All Ss were then told the following:

In any event the best way to get a high score for the group is for all the individual members to try to score as high as possible on all the subtasks.

We have also decided that when the results are in

> from all of our groups, we are going to see which ones scored the highest overall and give a prize for the best performance. So, if you are lucky and your group comes first, you will have a chance of winning some money. At the end of the experiment, I will ask you to fill out an evaluative questionaire to give us some feedback on how you felt about the experiment.

In the homogeneous condition, the experimenter stressed the general similarity of all subjects and indicated strongly that this was good for group performance. In the heterogeneous condition, stress was placed on the need for dissimilarity among the subjects and it was claimed that this would avoid problems of bias, thus boosting the chances of good group performance.

Each task was then individually introduced and explained. Care was taken to be certain that each subject fully understood what was expected. All subjects did the tasks in a fixed order which had been randomly selected: tracing, word, map; word, cutting, map; or map, shading, word.

On completing the nine tasks, subjects filled out a post-experiment evaluative questionaire. They were asked to guess the similarity--disimilarity of the other members of her group to her on a set of semantic-differential type scales along the following dimensions: age, sex, ethnicity, religion, socioeconomic status, intelligence, personality type, attitudes toward other cultures, degree of liberalism conservatism, and scores on the experimental tasks. These data provide insight into each subject's perception of how similar to and different from their group members they perceive themselves to be. In post-experiment interviews no subjects indicated that they guessed the real purpose of the

experiment.

Analyses of data: Scores were standardized for each subtask (e.g. Map 1) across groups and levels of instruction. After standardization, the scores for a particular subject on a particular task were averaged. These data were then cast in the form of a randomized blocks ANOVA with groups and instructions as the independent variables and the three task-types as dependent variables in separate analyses. Significant effects were further analyzed by multiple t-tests.

Manipulation checks were performed by collapsing over levels of instruction and comparing groups in the post-experimental questionaire.

Results

Manipulation Check: A Univariate Analysis of Variance was performed on a homogeneity/heterogeneity index. Subjects rated perceived similarity of other group members on 10 factors which included age , sex, ethnic background, religion, socioeconomic status, intelligence, cultural attitudes, personality, degree of liberalism, and scores on the experimental tasks. Indices could range from 10(very dissimilar) to 70(very similar). Subjects in the homogeneous conditions rated their fellow members significantly more similar(M=48.42) than did subjects in the heterogeneous groups(M=36.79), $F(1,46)=58.38$, $p<.001$.

Task Results: Table 1 gives the means, and differences between the means, on the Map task for the eight groups. The group by instruction effect was significant ($F(3,40)=4.09$, $p<.013$). Significant cell differences are also shown in Table 1.

Insert Table 1 about here

Both the discrepant and disjunctive conditions produced significantly different effects hetergeneous versus homogeneous group conditions. That is, under disjuctive instructions, the heterogeneous group performed better than the homogeneous one. The reverse was true under discrepant instructions where the homogeneous group did better. Neither the conjunctive or additive instructions were affected by the groups variable, although the additive situation produced higher performance in general than the conjunctive instructions.

Only the group main effect was significant using the word game dependent variable. ($F(1,40)=4.46, p < .05$). This effect was produced by the discrepant and conjunctive conditions (Table 2).

Insert Table 2 about here

The group by instruction interaction was also significant for the construction task data. ($F(3,40)=3.06, p < .04$). Here all instruction conditions performed better in the heterogeneous condition except disjunctive where the effect was reversed (Table 3).

Insert Table 3 about here

The task interactions are shown more clearly in figures 1 and 2, which present the data on the discrepant and disjunctive conditions from tables 1, 2, and 3.

Insert Figures 1 & 2 about here

The three tasks displayed marked changes across group composition in the discrepant instruction condition. These effects were markedly reduced(Word game) or reversed(Map & Construction tasks) under disjunctive instructions.

Discussion

Results of the present study indicated a Main Effect for Group on the Word game task in which perceived heterogeneous affiliation produced a significant improvement. Group X Instruction interactions were found on the Map and Construction tasks. Under disjunctive instructions the heterogeneous group performed better than the homogeneous group. This effect was reversed for the discrepant instructions where the homogeneous group performed better. On the construction task only the homogeneous group receiving disjunctive instructions outperformed its heterogeneous counterpart. A manipulation check showed perceived homogeneity/heterogeneity indices to be significantly different for the two subclasses.

The present data suggest that we need to include at least three theoretical factors in understanding our results. First,

there is task difficulty and familiarity. Related here is saliency of the task to the cultural group. Thus, performance on a cognitive task might be much more important to a group which holds intellectual performance in high regard. Second is the strength of group cohesiveness. Highly cohesive groups may tend to protect their least able members by either enhancing or degrading performance, depending on the criteria used to apportion rewards. The third factor is the ease and desirability of making intra-group comparisons. As Festinger (1954) noted some time ago, social comparison becomes more problematic as one moves away from tasks with clear standards of accomplishment. We can apply these factors to understanding the results from each task.

When interpreting the significant interaction present in the results of the Map task, one must attend to two of our suggested factors: perceived task difficulty and the effect this difficulty will have on the performance of the other group members. The interaction occurs primarily because of the differential effects of discrepant and disjunctive instructions. Remember that disjunctive information entails basing a group's final score on the singular best performance of one of the members. In a homogeneous group this would entail outperforming all of the others in the group which, from some perspectives, could dishonor others. Such a perspective might effect each subject's score in a negative fashion. In a heterogeneous group, this suppresion might not be as salient because the group is composed of people to whom one owes no loyalty (assuming that layalty is absent or miminal in hetergeneous groups). Therefore, the

individual would be likely to work hard even though the task is perceived to be very difficult.

The discrepant information involved the belief that all of the group members would reassemble at a later time and decide on a total group score. The theme is one of group co-operation and eventual fairness. In the homogeneous group the emphasis would most likely be on scoring as high as possible since the group benefits by the computation of a higher score. The subject can feel secure that her (good) performance will be rewarded by the other members of the group who are, after all, just like her. The situation in the heterogeneous group is just the opposite. Here one cannot be sure that the other people will agree on a fair distribution of the rewards: they might favor their own group (or non-islanders). One could hypothesize then that the potential or certainty of rewards (a monetary gain) would not be enough to serve as an incentive for high performance.

The results of the group receiving the additive instruction (summing each member's performance) were uniformly high for both homogeneous and heterogeneous groups, although the trend is clearly that hetereogenous groups do better than homogeneous ones. This finding is in accord with much of the research on group performance (cf. Ziller, 1976). The effect (additive groups performing rather well) is reinforced by the knowledge that an individual's high level of performance may compensate for poor performance by another, thereby benefiting the group.

The groups that received conjunctive instructions performed

uniformly lower than the other groups. In the homogeneous condition, scoring may be surpressed again out of a feeling of group solidarity. That is, since scoring is in terms of the poorest member, one may not wish to make the contrast between that person scoring lowest and subject excessively large. If the differences were large, it might be obvious who scored lowest and who did the best.

The simple motor task (construction) creates a different situation. This is a task in which it is relatively easy to judge the level of one's performance and estimate the best in a known group. If subjects know that the group's score will be based on the best individual performance (disjunctive) and feels that the differences between group members will be small, they are likely to do their best--again so that no one person has to be responsible for the group. Also, one could hypothesize that imaginal group fascilatation could occur as in Triplett's classic 1897 study. When you know little about the group, the need to reduce intra-group differences is of little saliency.

On the other hand, when the situation favors the least able of the group, or the likelihood that the group might favor such a person is high, the tendency would be to avoid embarrassing the low performer. In a heterogeneous group, this social restriction would not be present with the consequent elevation of scores.

In the word task, the tendency to reduce intra-group variation is more evident. This is a completely open ended task (that is, there are a very large number of words that can be constructed) with wide perceived variation in individual

abilities. So, even if you think you are good at the game, the wisest course (for the group) would be to surpress performance. With no obligation to the group members, this constraint would be removed---and it would be particularly absent in the discrepant condition when the others might be particularly reluctant to disfavor an outstanding performance. One might also hypothesize that this particularly verbal game would bring out a spirit of group competitiveness which would be unusally salient among Asian-Americans.

Methodologically, this study presents an experimental situation in which many of the effects of group performance can be studied without the uncontrolled variables created by the presence of other persons. The fact that the general superiority of heterogeneous groups over homogeneous ones was replicated, even in the absence of those groups lends support to the usefullness of the methodology.

The interaction of type of task with other variables is an interesting finding that merits additional investigation. Rarely have investigators looked for such task interactions, apparently believing that the effects were at best linear. Life is more complicated than that. Certainly, we shall need to analyze more carefully the nature of the task before making predictions about the impact of group composition and instruction manipulations.

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Table 1

Mean Differences for each Group-Instruction Subclass on the Map Task

Means	HOM-DCR (.595)	HET-DJN (.306)	HET-ADD (.298)	HOM-ADD (.244)	HOM-CON (-.204)	HET-CON (-.241)	HOM-DJN (-.477)	HET-DCR (-.522)
HOM-DCR(.595)		.289	.297	.351	.799**	.836**	1.072**	1.117**
HET-DJN(.306)			.008	.062	.510*	.547*	.783**	.828**
HET-ADD(.298)				.054	.502*	.539*	.775**	.820**
HOM-ADD(.244)					.448*	.485*	.721**	.766**
HOM-CON(-.204)						.037	.273	.318
HET-CON(-.241)							.236	.281
HOM-DJN(-.477)								.045

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

Note. Legend for abbreviations: HOM=Homogeneous HET=Heterogeneous DCR=Discriminant DJN=Disjunctive ADD=Additive CON=Conjunctive.

Table 2

Mean Differences for each Group-Instruction Subclass on the Word Task

Means	HET-DCR (.750)	HET-CON (.188)	HET-ADD (.175)	HET-DJN (.004)	HOM-DCR (-.029)	HOM-DJN (-.110)	HOM-ADD (-.421)	HOM-CON (-.548)
HET-DCR(.750)		.562	.575	.746*	.779*	.860*	1.171**	1.298**
HET-CON(.188)			.013	.184	.217	.298	.609	.736*
HET-ADD(.175)				.171	.204	.285	.596	.723*
HET-DJN(.004)					.033	.114	.425	.552
HOM-DCR(-.029)						.081	.392	.519
HOM-DJN(-.110)							.311	.438
HOM-ADD(-.421)								.127

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

Note. Legend for abbreviations: HET=Heterogeneous HOM=Homogeneous DCR=Discriminant CON=Conjunctive ADD=Additive DJN=Disjunctive.

Table 3

Mean Differences for each Group-Instruction Subclass on the Construction Task

Means	HOM-DJN (.751)	HET-CON (.396)	HET-DCR (.339)	HOM-CON (-.104)	HET-DJN (-.149)	HET-ADD (-.288)	HOM-ADD (-.432)	HOM-DCR (-.514)
HOM-DJN(.751)		.355	.412	.855**	.900**	1.039**	1.183**	1.265**
HET-CON(.396)			.057	.500*	.545*	.684*	.828**	.910**
HET-DCR(.339)				.443	.488	.627*	.771**	.853**
HOM-CON(-.104)					.045	.184	.328	.410
HET-DJN(-.149)						.139	.283	.365
HET-ADD(-.288)							.144	.226
HOM-ADD(-.432)								.082

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

Note. Legends for abbreviations: HOM=Homogeneous HET=Heterogeneous DJN=Disjunctive CON=Conjunctive DCR=Discriminant ADD=Additive.

Figure Caption

Figure 1. Group differences on the three tasks following discrepant information.

DISCREPANT INSTRUCTIONS

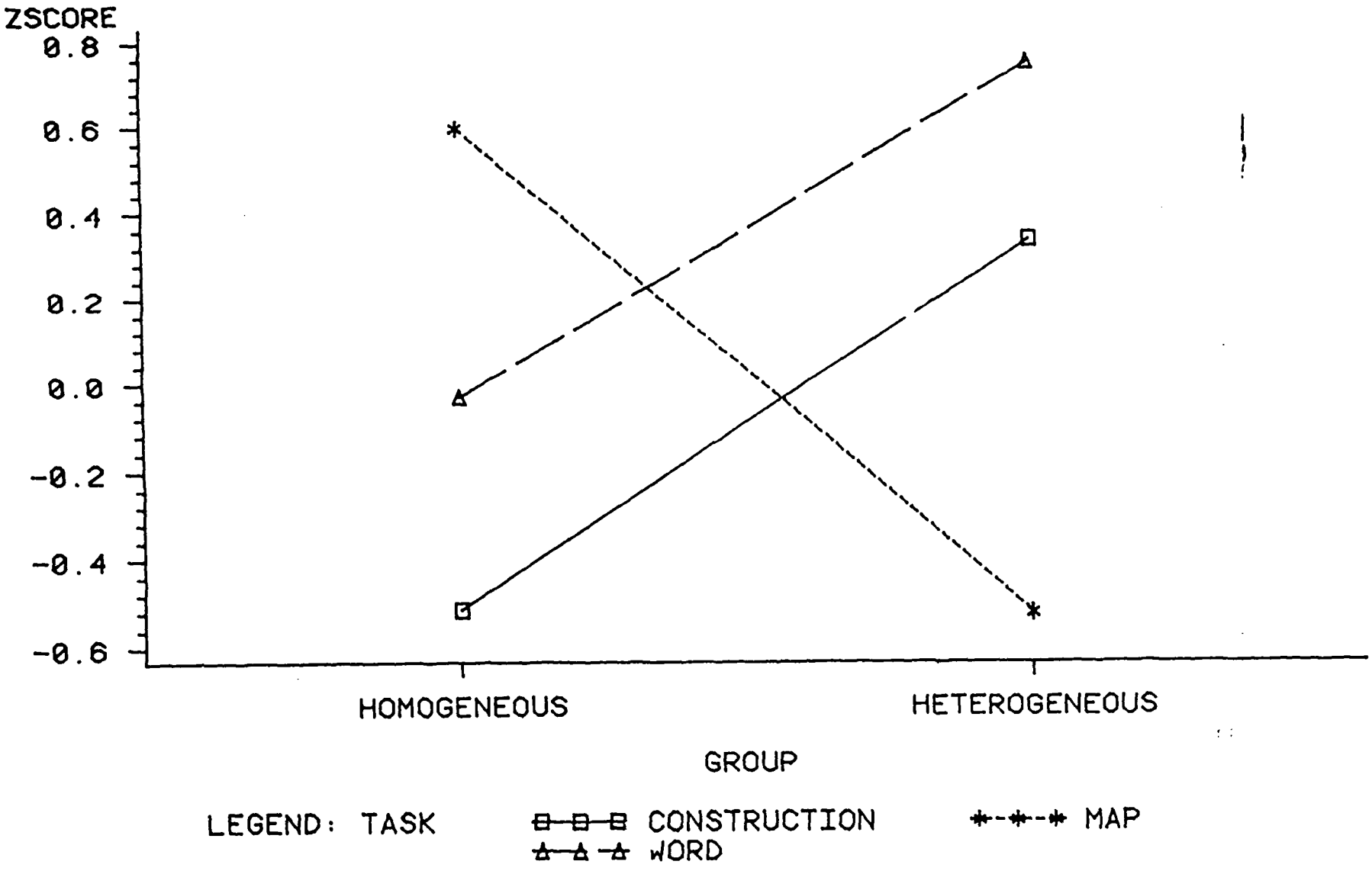
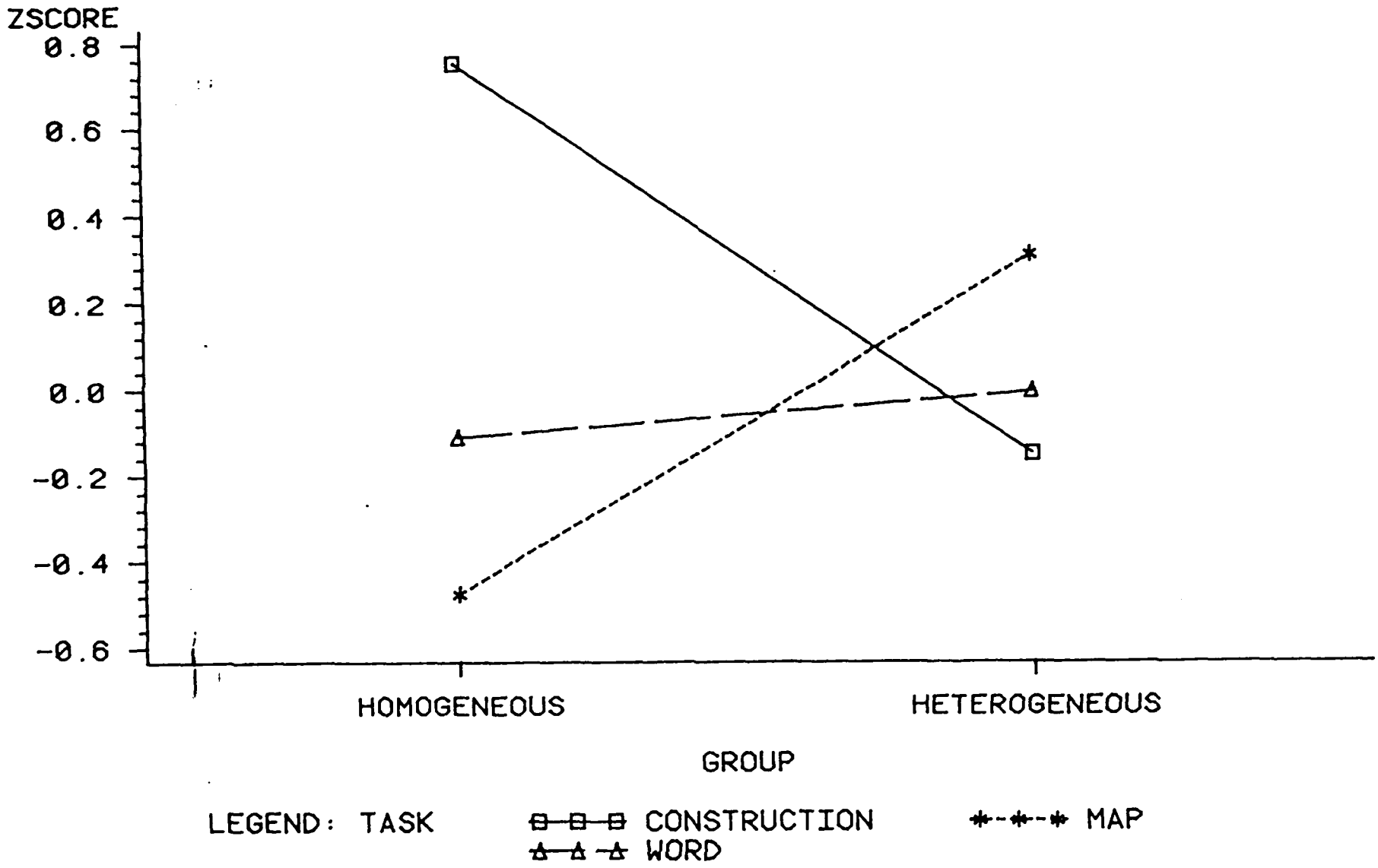


Figure Caption

Figure 2. Group differences on the three tasks following disjunctive instructions.

DISJUNCTIVE INSTRUCTIONS



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Selection and Preliminary Cataloging Section
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Library of Congress
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