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Best member performance versus group performance and the influences of maturity, size, and gender

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BEST MEMBER PERFORMANCE VERSUS GROUP PERFORMANCE AND THE INFLUENCES OF MATURITY, SIZE, AND GENDER

A DISSERTATION

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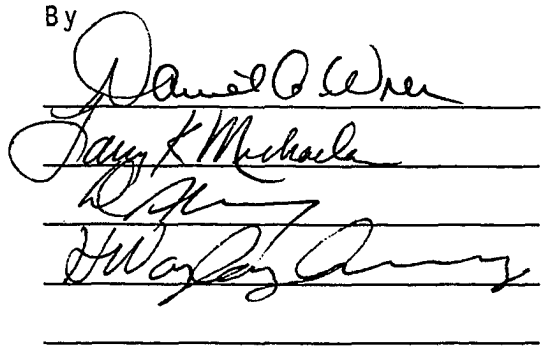

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

This study explored empirically the influences of maturity, gender composition, and group size on group ability to outperform its best member. The subjects were members of 220 Team Learning "permanent" groups ranging in sizes from 2 to 8 who participated in organizational behavior courses over a period of five years. Group and best member scores on mini-tests, taken repeatedly, as part of the instructional format administered, are used as measures of performance. The temporal order of taking these tests is used to indicate level of maturity. Gender ratio of females to males is used to measure group gender composition. The results indicated: 1) while both group and best member performances are significantly influenced by maturity, maturity does not seem, as far as this study is concerned, to enhance either the existence of assembly effect bonus or process loss; 2) while gender composition influenced group performance, that influence was not significant enough to enable either the group to outperform the best member or vice versa; and 3) the influence of size on the difference between group performance and best member performance is weak and unclear. Implications of these results and recommendations for future research are discussed.

CHAPTER I

THE PROBLEM

Introduction

The field of small groups is interesting and provides ample opportunities for research. It draws on various fields such as sociology and psychology and has serious implications for management. The inquiry into group effectiveness as decision making and problem solving mechanisms involves the comparison of group performance with individual performance. The interest in this area has been continuing for at least seven decades. This study continues and contributes to this tradition.

Purpose of Study

The purpose of this study is to provide empirical evidence for or against the achievement of assembly effect bonus in group consensus decision making and to investigate the influences of group maturity, group size, and group composition in terms of gender on group performance relative to the performance of the most knowledgeable member.

Need for Study

The evidence for group superiority is mixed and frequently contradicts conventional thinking. Several writers have pointed out potential sources of these inconsistencies.[1] Michaelsen et al. stated that "the lack of empirical support for the superiority of group decisions is in large part due to extremely artificial nature of the groups, tasks and/or settings in which the research has been conducted."[2] There was heavy reliance on ad hoc groups and excessive use of unfamiliar tasks and tasks that were contextually irrelevant.[3] There is a need for studies in which these shortcomings are avoided.

Furthermore, studies that investigate group maturity as it relates to group performance are scarce. This study intends to investigate group performance relative to

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[1]I. Lorge, D. Fox, J. Davitz, and M. Brenner, "A Survey of Studies Contrasting the Quality of Group Performance and Individual Performance," Psychological Bulletin 55 (1958):337-372; G. W. Hill, "Group Versus Individual Performance: Are N + 1 Heads Better Than One?" Psychological Bulletin 91 (1982):517-539; F. C. Miner, "Group Versus Individual Decision Making: An Investigation of Performance Measures, Decision Strategies and Process Losses/Gains," Organizational Behavior and Human Performance 33 (1984):112-124; L. K. Michaelsen, W. E. Watson, and R. K. Black, "A Realistic Test of Individual Versus Group Consensus Decision Making," The Journal of Applied Psychology 74 (1989):834-839.

[2]L. K. Michaelsen et al., pp. 2-3.

[3]M. E. Shaw, Group Dynamics: The Psychology of Small Group Behavior (New York: McGraw-Hill, 1981), pp. 446-448.

best member performance across time, hence taking into account influence of group maturity. The influences of gender and size on performances receive a great deal of interest. This study may contribute in this respect by investigating these influences in connection with group maturity.

Statement of Problem

In general, the problem is to determine if there is a significant difference between best member performance and group performance under specific conditions of group maturity, size, and gender composition.

Specifically, the problem is to answer the following questions:

1. Does group maturity increase the probability that groups will outperform their best member (i.e., achieve assembly effect bonus)?

2. Does group composition in terms of gender influence significantly the probability that groups will outperform their best member?

3. Does group size influence significantly the probability that groups will outperform their best member?

Limitations of Study

In this study, individuals performed first; then immediately performed in groups with identical tests. Learning from retesting was not controlled for.

There was a system of reward contingencies implemented in this study, the influence of which was not controlled for. These reward contingencies were present in all groups and for all individuals chosen for this study.

Most of the subjects in this study were actively dealing with interpersonal, group, and organizational issues. Their familiarity with these issues may have an influence on their performance in groups. This influence was not fully accounted for.

Assumptions

The study includes the following assumptions:

1. Time and amount of interaction experienced by groups is sufficient for group maturity to improve.

2. Mini-tests, the scores of which are used to indicate measures of performance, are of equal value and difficulty.

Order of Presentation

Chapter II consists of a review of selected relevant literature. It includes the concepts of assembly effect bonus and process loss, empirical evidence for and against group superiority, evaluation of some methodological issues and problems, and an overview of the literature on three important mediating variables--size, gender, and maturity.

Chapter III consists of the methodology utilized in this study to include research questions of procedures and measures, Chapter IV is reserved for reporting the results. Discussion, conclusions, and recommendations are presented in Chapter V.

CHAPTER II

REVIEW OF LITERATURE

Introduction

This chapter includes a review of relevant literature that is necessary to provide adequate theoretical and empirical background for this study. This review includes a brief overview of the value of small groups in decision making and problem solving, particularly in the area of management and leadership. Also, it includes two basic concepts (i.e., assembly effect bonus and process loss), their theoretical explanation, and a representative review of the empirical evidence for or against their occurrences. After that, small group research is evaluated in terms of the types of groups frequently used, the type of tasks employed, and the nature of research settings that characterize this body of research. Finally, the review concludes with a discussion of three important mediating variables, namely size, gender, and maturity, and their importance to group versus individual performances.

Groups and Management: A Brief Overview

The widespread use of committees, task forces, and project teams in business and governmental organizations and the reliance on juries in legal systems indicate a belief in the superiority of group decision making and problem solving over that of individuals.

Management and leadership theories and models, particularly those advocating participation, were based at least partially on the assumption that group decisions are superior to individual decisions. Mary Parker Follett was probably one of the earliest who suggested a philosophy and an approach to administration in which groups were clearly recognized as the core element.[1] She based her philosophy on the premise that an individual would find his/her true self only through the group. Accordingly she saw a society based upon a group principle rather than individualism. She advocated "integration" rather than compromise or competition.[2]

Mary Follett's philosophy was general and involved more than the issues of "small group" as commonly defined. However, central to her philosophy were groupness,

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[1]M. P. Follett, The New State: Group Organization the Solution of Popular Government (London: Longmans, Green, and Co., 1918), cited by Daniel Wren, The Evolution of Management Thought, 3rd ed. (New York: John Wiley and Sons, 1987), pp. 256-264.

[2]Daniel Wren, Evolution of Management Thought, pp. 256-264.

togetherness, and integration, as opposed to individualism and competition.

Likert postulated that effective organizations tend to be more participative than authoritative. Basic elements of these organizations are the use of group decision making and group methods of supervision.[3]

Vroom and Yetton's normative model of leadership and its partial test indicate that, at least in certain situations and/or with certain managers, group decision making is more effective in terms of quality and acceptance.[4]

Argyris, discussing the importance of working with groups, stated:

> . . . The search process in executive decision has become so complicated that group participation is essential. No one man seems to be able to have all the knowledge necessary to make an effective decision. . . . The value of a group is to maximize individual contributions.[5]

Anecdotal evidence, as exemplified by In Search of Excellence and Winning with Synergy, was also in favor of group decision making over that of the individual.[6]

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[3]R. Likert, The Human Organization (New York: McGraw-Hill, 1967), pp. 47-51.

[4]V. H. Vroom and P. W. Yetton, Leadership and Decision Making (Pittsburgh, PA: University of Ptitsburgh Press, 1973).

[5]C. Argyris, "Interpersonal Barriers to Decision Making," Management Classics, 2nd ed., Edited by M. Matteson and J. Ivancevich (Santa Monica, CA: Goodyear Publishing Co., 1981), p. 327.

[6]T. J. Peters and R. H. Waterman, In Search of Excellence (New York: Harper & Row, 1982); P. Corning and Susan Corning, Winning With Synergy (New York: Harper & Row, 1986).

These writings are among several that directly or indirectly exhibited a belief in the adage "two heads are better than one."

The research tradition that dealt with the proposition of group superiority in decision making and problem solving is that which contrasted individual performance with group performance. Research in this area has been going on for almost seven decades. There are variations as to the definitions of small group, tasks utilized, methodologies, terminologies, explanations and conclusions, among other things. Before proceeding to review relevant literature in this area, we need to define "small group."

Shaw, in his review, cited at least seven definitions of small group. Most of these definitions differ only in terms of emphasis on one or more of the features of group life.[7] Hare identified five features of group life thought to be essential to the differentiation between a collection of individuals and a "group." These features were: a) interaction, b) shared goals, c) development of norms, d) establishment of roles, and e) the existence of a network of interpersonal attractions.[8]

A widely cited definition of small group was proposed by Bales:

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[7]M. E. Shaw, Group Dynamics: The Psychology of Small Group Behavior (New York: McGraw-Hill, 1981), pp. 4-8.

[8]P. A. Hare, Handbook of Small Group Research (New York: The Free Press, 1976), pp. 4-5.

> A small group is defined as any number of persons engaged in interaction with each other in a single face-to-face meeting or a series of such meetings, in which each member receives some impression or perception of each other member distinct enough so that he can, either at the time or in later questioning, give some reaction to each of the others as an individual person, even though it be only to recall that the other was present.[9] (Italics mine.)

This definition, as can be seen, put more emphasis on interaction and perception of group existence.

Most other definitions were similar to Bales' in emphasizing one or two aspects of group life. Also almost all definitions tend to be in terms of similarities of members rather than differences or processes.[10] The exception was that suggested by Lewin. He emphasized viewing "group" in terms of interdependence:

> Conceiving of a group as a dynamic whole should include a definition of group which is based on interdependence of the members (or better, of the subparts of the group).[11]

While definitions may differ in terms of specificity, emphasis, and/or point of view, the correctness of these definitions is not necessarily jeopardized. Each may point to some important aspect of small group.[12]

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[9]R. F. Bales, Interaction Process Analysis: A Method for the Study of Small Groups (Cambridge, MA: Addison-Wisley, 1950), p. 33.

[10]M. E. Shaw, Group Dynamics, pp. 4-8.

[11]Kurt Lewin, Field Theory in Social Science (New York: Harper, 1951), p. 146.

[12]M. E. Shaw, p. 7.

For the purpose of this study, small group is defined as two or more persons up to a certain number engaged in face-to-face interaction in a series of meetings for the achievement of common goals. This definition encompasses at least three main points: a) direct interaction, b) mutual goal(s), and c) uncertainty as to the maximum size of small group.

The subjects in this study were members of Team Learning groups,[13] ranging in size from two to eight, who as members of these groups shared the mutual goal of learning materials in various organizational behavior and management development courses. Toward the achievement of this goal, they engaged in several meetings in face-to-face interaction where they worked on a variety of activities including experiential exercises, projects, objective exams, and essay exams.

Now we will consider two important concepts in individual versus group research: 1) the assembly effect bonus and 2) process loss.

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[13]L. K. Michaelsen, W. Watson, J. P. Gragin, and L. D. Fink, "Team Learning: A Potential Solution to the Problems of Large Classes," Exchange: The Organizational Behavior Teaching Journal 7 (1982):13-22; L. K. Michaelsen, W. Watson, and C. B. Schraeder, "Informative Testing--A Practical Approach for Tutoring with Groups," The Organizational Behavior Teaching Review 9 (1985):81-83.

Assembly Effect Bonus and Process Loss

Steiner identified three determinants of individual or group productivity: task demands, resources, and process. Task demands include the requirements imposed on the individual or group by the task itself or by the rules under which the task must be performed. These requirements determine the relevance of resources. Resources include knowledge, abilities, skills, and tools needed to perform the task. Process consists of the steps and actions taken by an individual or group in order to put resources and task demands together to perform the task. It consists of the behaviors, or series of behaviors, exhibited in the performance of the task. It includes intrapersonal and interpersonal actions related directly or indirectly to the performance of the task.[14]

Potential productivity (maximum productivity) of an individual or group is determined by the matching of resources and task demands. Stated alternatively, given task demands and given available resources, at least theoretically, one should be able to determine the maximum productivity. Steiner asserted that productivity "can be inferred from a thorough analysis of task demands and available resources."[15] What the individual or group actually produces is called actual productivity, and, in addition,

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[14]I. D. Steiner, Group Process and Productivity (New York: Academic Press, 1972), pp. 5-8.

[15]Ibid., p. 8.

it requires the willingness of members to contribute their resources to task performance. Motivation to do task is an important element in productivity. The appropriateness of the process determines how well actual productivity approximates potential productivity. The difference between the two is called process loss.[16]

Ideally under Steiner's formulation, the appropriate method of comparing individual performance with group performance is to solve his equation:

Actual Productivity = Potential Productivity - Process Loss

for both the individual and the group. Then the end results are compared. Implicit in this formulation is the comparison of actual performances in terms of their relativity to potential performances. Stated simply, process loss in terms of the individual case is compared with the process loss in the group case. This is not exactly the way it is actually done.

Miner pointed out that "Steiner's concept [of group potential] can be well understood, but in operational terms it is subject to methodological variations."[17] Group performance was often compared to average individual performance, the performance of the best individual, and/or the

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[16]Ibid., p. 9.

[17]F. C. Miner, Jr., "Group Versus Individual Decision Making: An Investigation of Performance Measures, Decision Strategies, and Process Losses/Gains," Organizational Behavior and Human Performance 33 (1984):113.

performance as determined through statistical pooling. These measures were taken as indicators of group potential.[18]

In contrast to Steiner's process loss, Hackman and Morris have suggested the possibility of process gain. This gain depends on the influence of process on three variables (task performance strategies, member effort, and member knowledge and skill). In principle, group interaction process could lead to reformulating existing strategies or generating new ones to execute the task more effectively. Also, interaction could increase motivation (increase member effort), hence process gain. Member knowledge and skill could be increased as a result of learning through interaction, which in turn may lead to process gain.[19]

The process gain concept is very similar to assembly effect and assembly effect bonus introduced by Collins and Guetzkow. They postulated that:

> An assembly effect occurs when the group is able to achieve collectively something which could not have been achieved by any member working alone or by a combination of efforts. The assembly effect bonus is productivity which exceeds the potential of the most capable member and also exceeds the sum of the efforts of the

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[18]Ibid., pp. 112-124.

[19]J. R. Hackman and C. B. Morris, "Group Tasks, Group Interaction Process and Group Performance Effectiveness: A Review and Proposed Integration," Vol. 8, Advances in Experimental Social Psychology, Edited by L. Berkowitz (New York: Academic Press, 1976), pp. 47-99, cited by J. E. McGrath, Groups: Interaction and Performance (Englewood Cliffs, NJ: Prentice-Hall, 1984), pp. 133-136.

group members working separately.[20] (Italics theirs.)

According to Collins and Guetzkow, the potential to achieve assembly effect bonus is present in any group. However, the realization of this potential is largely dependent on the ability and skill of group members to build effective interpersonal relations. Building such relations is a difficult social task that requires time and energies that could have been spent working in the task.[21]

Several explanations of process loss/gain have been advanced. Latane, Williams, and Harkins explained it by social loafing.[22] Steiner explained it by inappropriate resource utilization.[23] Maier explained it by other negative aspects of group process such as social pressure, individual domination, and conflicting secondary goal (i.e., winning the argument.)[24] Maier and Hoffman have suggested

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[20]B. E. Collins and H. Guetzkow, A Social Psychology of Group Processes for Decision Making (New York: John Wiley & Sons, 1964), p. 58.

[21]Ibid., pp. 58-68.

[22]B. Latane, K. Williams, and S. Harkins, "Many Hands Make Light the Work: The Causes and Consequences of Social Loafing," Journal of Personality and Social Psychology 37 (1979):822-832.

[23]Steiner, Group Process and Productivity, pp. 7-9.

[24]N.R.F. Maier, "Assets and Liabilities in Group Problem Solving: The Need for an Integrative Function," Psychological Review 74 (1967):239-249.

that process loss was due to adoption of satisficing rather than maximizing goals.[25]

It seems that, by and large, process loss or process gain takes place depending on the outcome of the interaction process with respect to the participants. If the interaction process should be judged as inhibitory, then process loss would be expected, and one or more of the above explanations would follow. If the interaction process should be judged as facilitating, then process gain would occur, as will be explained later.

Latane et al. attributed process loss to social loafing and described it under Latane's theory of social impact which they summarized in the following fashion:

> If a person is the target of social forces, increasing the number of other persons also in the target group should diminish the pressures on each individual because the impact is divided among the group members. In a group performance situation in which pressures to work come from outside the group and individual outputs are not identifiable, this division of impact should lead each individual to work less hard. Thus, whether the subject is dividing up the amount of work he thinks should be performed or whether he is dividing up the amount of reward he expects to earn with his work, he should work less hard in groups.[26]

Simply stated and in agreement with this theory, social loafing is the "phenomena" in which individuals exert less effort when working with others relative to when working alone. Latane and his associates identified three

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[25]N.R.F. Maier and L. R. Hoffman, "Quality of First and Second Solutions in Group Problem Solving," Journal of Applied Psychology 44 (1960):278-283.

[26]Latane et al., "Many Hands Make Light the Work," p. 830.

causes of social loafing. First is the attribution and equity in which participants engage in a faulty attribution process leading to an attempt to maintain equitable division of labor. They start by judging their performance more favorable to others' and attempt to lower performance possibly because they think working hard in aid of the less competent is not justified.

The second possible reason is setting submaximal goals. Participants may redefine the task and adopt a less than maximizing goal. Unfortunately, Latane et al. explained this cause only in the context of their two experiments in which the tasks were clapping and cheering. They did not elaborate on why participants were expected to redefine the task. In any case, they did not, at least in the context of their experiments, find this cause to be highly plausible.

Finally, they suggested that social loafing was possibly due to the lessened contingency between input and outcome. "Since individual scores are unidentifiable when groups perform together, people can receive neither precise credit nor appropriate blame for their performance."[27] This situation was thought to be conducive for individuals to be at least less enthusiastic about exerting the maximum effort.[28]

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[27]Latane et al., "Many Hands Make Light the Work:" p. 830.

[28]Ibid., pp. 829-830.

On the other hand, assembly effect bonus or process gain was explained on the basis that interaction was facilitating. In group setting and with interaction, two main outcomes were possible. First was the capacity of the individual to learn within the group setting. Second was the opportunity for cognitive stimulation.[29]

These ideas were based on Zajonc's formulation of social facilitation. Basically, the presence of others is likely to be arousing (increase drive level) so that more energy is invested by the individual. Stated alternatively, the presence of others is motivating for the individual to put more effort in learning and performing. Furthermore, the discussion with others may contain task-relevant stimuli that elicit responses or actions by the individual that may not surface when the individual is working alone.[30]

These concepts and their supporting arguments lead to at least three competing propositions:

1. Groups significantly outperform their best member (i.e., assembly effect bonus).

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[29]H. Lamm and G. Trommsdorff, "Group Versus Individual Performance on Tasks Requiring Ideational Proficiency: A Review," European Journal of Social Psychology 3 (1973):361-388; G. W. Hill, "Group Versus Individual: Are N + 1 Heads Better Than One?" Psychological Bulletin 91 (1982):517-539.

[30]R. B. Zajonc, "Social Facilitation," Science 149 (1965):269-274.

2. Best members significantly outperform their groups (i.e., process loss).

3. Groups and their best members are not significantly different from each other in performance.

Now we will consider some of the empirical evidence related to these concepts.

Group Superiority: The Empirical Evidence

In most cases, empirical research failed to find evidence of the occurrence of assembly effect bonus. Oftentimes group performance was found to exceed that of the average individual but less than that of the best-member performance.

In a 1958 review of studies investigating individual versus group performance, Lorge, Fox, Davitz, and Brenner arrived at the following conclusion:

> In general, in the evaluation of the relative quality of the products produced by groups in contrast to those produced by individuals, the group is superior. The superiority of group, however, all too frequently, is not as great as would be expected from an interactional theory. In many studies, the product of the "best" individual is superior to that of the "best" group.[31] (Italics mine.)

Some 24 years later in a similar review, Hill reached essentially the same conclusion that group performance "was often inferior to that of the best individual . . . especially if the committee [group] is trying to solve a complex problem

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[31] I. Lorge, D. Fox, J. Davitz, and M. Brenner, "A Survey of Studies Contrasting the Quality of Group Performance and Individual Performance," Psychological Bulletin 55 (1958):369.

and if the committee [group] contains a number of low-ability members."[32]

Several studies will be reviewed in the following pages starting with those few that seem to have support for the occurrence of assembly effect bonus. This review is intended to be representative rather than comprehensive.

Empirical Evidence of Assembly Effect Bonus

Watson conducted an experiment to test the "intellectual efficiency" of groups as compared to the efficiency of group members working individually and by themselves. His subjects were graduate students assigned to twenty groups. Subjects were given as individuals and as groups basic words such as "universal" and "educators." The task was to construct individually and in groups as many words as possible using the letters of these basic words.

The analysis included contrasting the number of words constructed by individuals to that constructed by groups. Watson found that groups constructed significantly more words than individuals. He concluded that "group thinking" was significantly superior to that of the best member of the group.[33]

Yuker examined group memory versus individual memory. A story was read to a group of four persons of the

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[32]G. W. Hill, "Group Versus Individual:" p. 535.

[33]G. B. Watson, "Do Groups Think More Efficiently Than Individuals?" Journal of Abnormal and Social Psychology 23 (1928):228-336.

same sex, and three written recalls were collected. Recalls were made by individuals, then by the group, and finally by individuals. Group recalls were obtained under various conditions of competition and cooperation. The written recalls were compared on the basis of their quality.

Group recall was found to be superior to individual recall, including the one with best memory. Also, it was shown that group under cooperative conditions exhibited better recall than group under competitive conditions.[34]

Hall and Williams found some evidence of assembly effect bonus. Their study was primarily concerned with the effect of training in group dynamics and decision making on group performance. They compared performances of 30 untrained groups with 30 trained groups on the 12 Angry Men decision-making task. They found that 50 per cent of the trained groups and 30 per cent of the untrained groups were able to achieve the assembly effect bonus.[35]

Nemiroff and King conducted a similar study and obtained similar results. They found that 72 per cent of the instructed (trained) groups and 33 per cent of the

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[34]H. E. Yuker, "Group Atmosphere and Memory," Journal of Abnormal and Social Psychology 51 (1955):17-23.

[35]J. Hall and M. S. Williams, "Group Dynamics Training and Improved Decision Making," The Journal of Applied Behavioral Sciences 6 (1970):39-68.

uninstructed groups were able to perform better than the most proficient member.[36]

Hall, Mouton, and Blake compared decisions made by groups through interaction and decisions obtained by statistically pooling individual judgments. They utilized the film 12 Angry Men to obtain their measures of performance. They found that group judgment under interaction condition was superior to group judgment under pooling condition and that "decisions emerging from interaction would approximate or equal the best individual judgment."[37]

This study did not provide clear support for the assembly effect bonus. However, it revealed, as would be expected, that direct interaction accounts, at least partially, for group effectiveness.

These studies suggested empirical basis for at least three conclusions: 1) assembly effect bonus was achievable; 2) at least suggestively, group outcome was partially a function of interaction; and 3) training in problem solving and group dynamics enhanced the achievement of the assembly effect bonus. This later conclusion was in support of Steiner and Collins & Guetzkow's contentions that group effectiveness was in part a function of group ability to

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[36]P. M. Nemiroff and D. C. King, "Group Decision Making Performance as Influenced by Consensus and Self-Orientation," Human Relations 28 (1975):1-21.

[37]E. J. Hall, J. S. Mouton, and R. R. Blake, "Group Problem Solving Effectiveness Under Conditions of Pooling vs. Interaction," The Journal of Social Psychology 59 (1963):147-157.

resolve problems emanating from task and interpersonal environment.[38] This ability was probably influenced positively by training in decision making and group dynamics.

In the following section, we will discuss some of the studies that failed to find evidence for the achievement of assembly effect bonus.

Empirical Evidence of Process Loss

The majority of empirical research in the area of individual versus group performance resulted in evidence of process loss rather than assembly effect bonus (process gain). The findings of this body of research not only contradict the studies reviewed above but also contradict conventional thinking and "popular" beliefs in various management and leadership theories.[39]

Marquart extended and reanalyzed a study previously conducted by Marjorie Shaw. Shaw obtained measures of performance on the basis of solutions to complex problems of the eureka type (problems with one correct answer that is objectively determinable and recognizable) and found that groups performed better than average individuals.[40] Marquart, in her extension and reanalyses, compared group

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[38] I. D. Steiner, Group Process and Productivity, pp. 6-9; B. E. Collins and H. Guetzkow, A Social Psychology of Group Processes, pp. 56-68.

[39] See the first section of this chapter for a brief discussion and relevant citations.

[40] M. E. Shaw, "A Comparison of Individuals and Small Groups in the Rational Solution of Complex Problems," American Journal of Psychology 44 (1932):491-504.

performance to the performance of the best individual. She found group performance to be inferior to that of the best member. She attributed these results to cultural influences that favored competition over cooperation.[41]

In brainstorming, the evidence was not for group superiority either. In at least two studies, individuals were found to exceed groups in both number of ideas generated and in the selection of the "best" idea.[42]

In two studies where the influence of training in group dynamics was investigated, it was found that group decisions improved after training but not enough to achieve assembly effect bonus. In both studies, the best member outperformed the group.[43]

Miner used the Winter Survival Exercise to consider the performance of group as compared with the actual best member and the selected best member (the member selected by the group as the best). He found that group performance

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[41]D. I. Marquart, "Group Problem Solving," Journal of Social Psychology 41 (1955):103-113.

[42]W. K. Graham, "Acceptance of Ideas Generated Through Individual and Group Brainstorming," The Journal of Social Psychology 101 (1977):231-234; O. Harari and W. K. Graham, "Tasks and Task Consequences as Factors in Individual and Group Brainstorming," The Journal of Social Psychology 95 (1975):61-65.

[43]D. J. Fox and I. Lorge, "The Relative Quality of Decisions Written by Individuals and by Groups as the Available Time for Problem Solving is Increased," The Journal of Social Psychology 57 (1962):227-242; P. M. Nemiroff, W. A. Pasmore, and D. L. Ford, "The Effect of Two Normative Structural Intervention on Established and Ad Hoc Groups: Implications for Improving Decision Making Effectiveness," Decison Sciences 7 (1976):841-855.

was higher than the selected best member but less than the actual best member. The selected best member, however, performed better than the average. Group seems to be able to identify its better member but unable to identify its best member.[44] This conclusion collaborates other conclusions that ". . . groups seem to be generally incapable of fully knowing the contributions of individuals who have high-quality decisions."[45]

Campbell utilized a sample of second- and third-line managers from a public utility who were presented with the Change of Work Problem to compare individual solutions when working alone, individual solutions when participating in group discussions, and group solutions. He found that group decisions were inferior to even the average member. He speculated that group discussion was inhibitory and produced inferior results.[46]

Yetton and Bottger presented their subjects, who were managers and graduate students participating in a variety of management development programs, with the NASA Moon Survival Problem to compare, among other things, best member decisions with that of interacting groups. They

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[44]F. C. Miner, Jr., "Group Versus Individual Decision Making:" pp. 112-124.

[45]B. Schoner, G. R. Rose, and G. C. Hoyt, "Quality of Group Decision: Individual Versus Real and Synthetic Groups," Journal of Applied Psychology 59 (1974):424-432.

[46]J. P. Campbell, "Individual Versus Group Problem Solving in an Industrial Sample," Journal of Applied Psychology 52 (1968):205-210.

failed to find evidence of assembly effect bonus and attributed group outcome to members' abilities rather than interaction. The best member performance defines the upper limit of group outcome.[47]

In the same vein, Libby et al. suggested that ". . . the ability to actually weigh judgments based on relative expertise [of members] is a significant determinant of group performance."[48]

Tuckman and Lorge proposed that the basis for group superiority is not interaction but rather the greater probability of its containing at least one member who can solve the problem.[49]

These studies, among others, seem to provide empirical evidence that is inconsistent with studies reviewed earlier and with what some popular management and leadership theories seem to imply. Furthermore, neither on the basis of theoritical formulations nor on the basis of empirical evidence can we establish with confidence the plausibility of the occurrence of either assembly effect bonus or process loss. These inconsistencies are indicative of

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[47]P. W. Yetton and P. C. Bottger, "Individual Versus Group Problem Solving: An Empirical Test of a Best-Member Strategy," Organizational Behavior and Human Performance 29 (1982):307-321.

[48]R. Libby, K. T. Trotman, and I. Zimmer, "Member Variation, Recognition of Expertise, and Group Performance," Journal of Applied Psychology 72 (1987):84.

[49]J. Tuckman and I. Lorge, "Individual Ability as a Determinant of Group Superiority," Human Relations 15 (1962):45-51.

possible problems in small group research. This is the area that is considered next.

Problems with Groups, Tasks, and Settings in Groups Research

Hackman noted that fields of scientific inquiry are characterized by uneven distribution of scholarly efforts across the various substantive and methodological aspects of problems under investigation.[50] At least on the methodological side, research of small groups is a good example of this unevenness.

Shaw identified, among other things, three problems that characterize small group research. There is an overemphasis on laboratory settings rather than natural settings, overemphasis on ad hoc groups rather than established mature groups, and excessive employment of trivial and artificial problems rather than real tasks.[51]

These problems are not independent. The desire for rigor, precise measurements, controls, and experimental manipulation makes laboratory settings more preferable. By the same token, however, real tasks and established groups may complicate the convenience and expediency in meeting these requirements. Also, they may require more complex and sophisticated methodological and analytical procedures for the achievement of effective experimental measurements,

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[50]J. R. Hackman, "Effects of Task Characteristics on Group Products," Journal of Experimental Social Psychology 4 (1968):162-163.

[51]M. E. Shaw, Group Dynamics: p. 446.

controls, and manipulations. Such procedures may not be readily available under research constraints of time, cost, and possibly knowledge.

Preference for rigor leads to an overemphasis on laboratory settings which, in turn, leads to overemphasis on ad hoc groups and trivial tasks.[52] The overall result is an uneven distribution of methodological aspects of individual versus group research. That may, at least partially, account for the inconsistencies and contradictions that characterize this tradition of research. Also, it points out a need for the correction of this situation.

Overemphasis on Artificial Settings

In terms of contexts and settings, there are two related problems in individual versus group research. First, there is an overemphasis on laboratory research. Almost all the studies I reviewed in relevance to this paper have been laboratory studies. Shaw, whose review was more comprehensive, has reached essentially the same conclusion.[53]

The problem is not necessarily on the use of laboratory settings but rather on the lack of emphasis on alternative methodologies and settings. Without these alternatives--or, better, a reasonable number of these alternatives--we may not be able to check with certainty the short

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[52]Ibid., pp. 446-448.

[53]M. E. Shaw, Group Dynamics: pp. 445-448.

comings of laboratory studies. The most notable shortcoming is the lack of external validity (i.e., inability to generalize findings).[54]

This concern is arguably justified in light of lack of theory and inconsistencies despite approximately seven decades of active research. There is an obvious need to conduct other types of studies such as field experiments, field studies, longitudinal studies, and so forth.

The second problem stems in part form the first one. To meet demands of control, effective manipulation, and precise measurements, laboratory settings are often overly simplified. Collins and Guetzkow pointed out the importance of time for the group to develop, resolve conflicts, identify skills, identify task demands, and so forth, so that the group will be more effective.[55] Katz noted the importance of longevity to interpersonal relations and task demands.[56] Studies in individual versus group performance rarely allow sufficient time for these necessary processes to take place.

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[54]Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart, and Winston, Inc., 1973), p. 400.

[55]B. E. Collins and H. Guetzkow, A Social Psychology of Group Processes for Decision Making (New York: Wiley Publishing Co., 1964), p. 60.

[56]Ralph Katz, "The Influence of Job Longevity on Employee Relations to Task Characteristics," Human Relations 31 (1978):703-725.

Contextual elements such as rewards and feedbacks are usually included in group effectiveness models[57] but almost have never been incorporated in this tradition of research. Typically, the research utilized ad hoc groups, very short time periods (e.g., 50 minutes), and trivial tasks. Subjects are not presented with clear and meaningful incentives to participate in the group and rarely presented with meaningful feedback that provides opportunities for learning, motivation, and error correction.

This kind of setting is arguably very artificial and far removed from real group settings and contexts. This, in addition to the lack of theory and the inconsistencies of findings despite seven decades of active research, makes the need for studies employing more realistic settings and contexts that much more apparent. It is the fulfillment of this need that hopefully will be one of the contributions of this study. The settings and contexts of groups in this study, as will be discussed in the next chapter, are relatively more realistic.

Overemphasis on Ad Hoc Groups

In their 1958 review, Lorge, Fox, Davitz, and Brenner warned against the use, or at least excessive use, of ad hoc groups:

> A common and dangerous practice is to generalize the principles valid for ad hoc groups to traditioned

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[57]Deborah L. Gladstein, "Groups in Context: A Model of Task Group Effectiveness," Administrative Science Quarterly 29 (1984):499-517.

> [established or natural] groups. The ad hoc group is treated as a microscopic model of the traditioned groups. . . . It is . . . possible that ad hoc and traditioned groups behave in accordance with their individual principles. . . . The microscopic approach is a prerequisite to understanding the genuine group but is not itself the understanding.[58]

This concern, at least in practice, was not taken seriously since most of the previous research in this area used ad hoc groups rather than established or natural groups. Hill's 1982 review of research on individual versus group performance covered 61 years of research and included only one study in which established groups were utilized.[59] Among studies reviewed for the purpose of this paper, very few have used what could be considered established groups.[60]

The concern about ad hoc groups is not necessarily unjustified. Collins and Guetzkow, discussing the conditions under which assembly effect bonus could be achieved, stated that "members must spend time developing interpersonal relationships which they could have spent working in

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[58]I. Lorge, D. Fox, J. Davitz, and M. Brenner, "A Survey of Studies Contrasting the Quality of Group Performance and Individual Performance," pp. 338-370.

[59]G. W. Hill, "Group Versus Individual:" pp. 517-539.

[60]J. Hall and M. S. Williams, "Group Dynamics Training and Improved Decision Making," pp. 39-68; P. M. Nemiroff et al., "The Effects of Two Normative Structural Interventions on Established and Ad Hoc Groups:" pp. 841-855; D. L. Ford, P. M. Nemiroff, and W. A. Pasmore, "Group Decision Making Performance as Influenced by Group Tradition," Small Group Behavior 8 (1977):223-228; R. Libby, K. T. Trotman, and I. Zimmer, "Member Variation, Recognition of Expertise, and Group Performance," pp. 81-87.

the task."[61] A convincing argument could be made that this condition would not be met in the context of ad hoc groups. Moore and Anderson, when explaining the result of their study in which there were no differences between individual performance and group performance, stated that:

> The subjects who were assigned to groups had not worked together before the experiment began. It could be that part of problem-solving "energy" of group members was diverted from the solution of [task] problems to the solution of interpersonal problems.[62]

The literature on group development provides additional support for these concerns. Groups, by and large, require time for orientation and resolution of conflicts till they reach a stage of productivity to which most of the energies are directed.[63] Ad hoc groups, mainly due to time limitations, are expected to be in the orientation, or at best in the conflict resolution stage, where most of the energies are directed toward interpersonal problems rather than task problems.

Another area in which ad hoc groups differ from established groups was noted by Hall and Williams. They compared decision making performances of established and ad hoc groups and inferred from their analyses that the two groups approached conflict differently:

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[61] B. E. Collins and H. Guetzkow, A Social Psychology of Group Processes for Decision Making, p. 60.

[62] O. K. Moore and S. B. Anderson, "Search Behavior in Individual and Group Problem Solving," American Sociological Review 19 (1954):714.

[63] A review of literature in the area of group development can be found in M. E. Shaw's Group Dynamics:, pp. 98-109.

> Established group creativity reflects an ability to treat conflict objectively and as problem oriented, while ad hoc [group respond in a manner that produce compromise which] reflects a tendency to view conflict among strangers as having potential affective consequences which preempt the importance of the task.[64]

Empirical studies in which ad hoc group performance was contrasted with established group performance are scarce. Also, the conclusions seem to be inconsistent. Hall and Williams used the film 12 Angry Men to compare the performances of 20 ad hoc groups with 20 established groups. They found that decisions made by established groups were superior to those made by ad hoc groups.[65] The opposite conclusion was reached in another study. Ford, Nemiroff, and Pasmore used the Lost at Sea Exercise to contrast performances of 24 ad hoc groups and 24 established groups. They found ad hoc groups to be more effective than established groups.[66]

In short, the overwhelming majority of studies used ad hoc groups. By the same token, there are clearly voiced concerns about the value of data obtained on the basis of these groups. I suggest that research which utilizes established groups is needed for us to be able to clarify some of the persistent inconsistencies in research

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[64]Jay Hall and Martha Williams, "A Comparison of Decision-Making Performances in Established and Ad Hoc Groups," Journal of Personality and Social Psychology 3 (1966):221.

[65]Ibid., pp. 214-222.

[66]D. L. Ford, P. M. Nemiroff, and W. A. Pasmore, "Group Decision-Making Performance as Influenced by Group Tradition," Small Group Behavior 8 (1977):223-228.

findings. Insistence on utilizing ad hoc groups for the last 50-70 years did not produce what was expected.

New strategies need to be considered even if the price was loss of expediency, convenience, or even degree of rigor. The shift of emphasis from ad hoc groups to established groups is one strategy and is the one employed in this particular investigation. Furthermore, this study involves comparing performances at earlier periods of group formation and at later periods. These comparisons should shed some light into influence of group maturity and possibly ad hoc/established group controversies.

Overemphasis on Trivial Tasks

Most of the tasks used in small group research have been characterized as trivial or artificial. In 1950, Carter and his associates investigated leadership behavior differences versus task differences. They noted the following concern about their findings which were related to the nature of tasks and situation in their study:

> It is hoped that those demonstrating leadership behavior in such 'artificial' miniature situations will later perform similarly when faced with real leadership problems.[67] (Italics mine)

This concern about artificiality of tasks and problems in small group research was also voiced by Lorge and his associates in their 1958 review. They noted that research suffered from a lack of reality and that problems

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[67]L. Carter, W. Haythorn, and M. Howell, "A Future Investigation of the Criteria of Leadership," Journal of Abnormal and Social Psychology 45 (1950):350.

and tasks were "far removed from the genuine and the real."[68] Similarly, Lamm and Trommsdorff in their 1973 review of studies comparing individual and group performances on brainstorming problems noted the simplicity of tasks and artificiality of contexts in these studies. These task contexts, as they explained, are hardly susceptible to group organization. Activities such as identification of information and skills, making appropriate assignments, coordination, and combining subproducts into end products might not be exhibited clearly in such artificial settings.[69]

In 1982, Shaw echoed similar concerns. He identified several problems in small group research, one of which was the "tendency toward the elegant treatment of trivial problems."[70]

Tasks employed in small group research tend to be unfamiliar, irrelevant, or foreign to the settings in which they are used, and possibly have insignificant value or outcome for those performing them. Notable examples of these tasks are the film 12 Angry Men, the NASA Moon Survival Problem, the Lost at Sea Problem, the Thumb Problem, and the Sub-Artic Survival Problem. Subjects are usually asked

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[68] I. Lorge et al., "A Survey of Studies Contrasting the Quality of Group Performance and Individual Performance," p. 357.

[69] H. Lamm and G. Trommsdorff, "Group Versus Individual Performance on Tasks Requiring Ideational Proficiency: A Review," p. 385.

[70] M. E. Shaw, Group Dynamics: p. 446.

to respond to a hypothetical situation such as crashing at sea, crashing in the sub-Artic, or getting isolated on the moon from mother ship. Typically, they are supposed to order items in terms of their importance to their survival under such circumstances or similar ones.

These tasks are typical in small group research, as noted above. My evaluation of the studies relevant to this paper is consistent with others. I was only able to locate three studies that employed tasks which could be considered real or relevant, taking into account the type of subjects involved.[71] The NASA Moon Survival Problem, for example, is probably relevant, interesting, and important to those in the aviation and/or space exploration areas, but unfamiliar, foreign, and probably boring to the typical sophomore students who are often the subjects in small group research.

The problem is not necessarily about the use of these tasks per se, but rather about the excessive reliance on these tasks almost to the exclusion of the alternatives (i.e., more realistic tasks). There is an obvious need to correct this unevenness (i.e., overemphasis on trivial problems) so that we may account for some of the

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[71]R. Libby et al., "Member Variation, Recognition of Expertise, and Group Performance," Journal of Applied Psychology 72 (1987):81-87; J. Tuckman and I. Lorge, "Individual Ability as Determinant of Group Superiority," Human Relations 5 (1962):45-51; B. Schoner, G. R. Rose, and G. C. Hoyt, "Quality of Group Decision: Individual Versus Real and Synthetic Groups," Journal of Applied Psychology 59 (1974):424-432.

inconsistencies in findings, improve our abilities to generalize our findings, and hopefully approach a better state to organize findings in a theoretically meaningful way.

Tasks employed in this study are relevant, realistic, and consequential to those who performed them. In that way, this study should provide an attempt to avoid this methodological unevenness that seems to characterize individual versus group research.

In short, we discussed in this section three interrelated problems that characterize individual versus group research. They were: 1) overemphasis on artificial settings, 2) ad hoc groups, and 3) trivial (unrealistic) tasks. These problems may account at least partially for inconsistencies and contradictions exhibited in this tradition of research.

This study attempts to avoid some aspects of these problems and hopefully will contribute toward evening out the distribution of research emphasis.

The next section is devoted to the discussion of the influences of size, gender, and maturity on group performance and group ability to achieve assembly effect bonus.

Influences of Size, Gender, and Maturity

Group size and group composition in terms of gender are frequently researched and thought to have noticeable

influence on group performance. Group maturity or life span is relatively less emphasized in empirical research.

These three factors are reviewed on the basis of existing literature. The main concern is about their influences, if any, on group performance versus best member performance.

Size

Research on group size has been conducted to investigate the influence of size on various aspects of group such as performance, member attitudes, group interaction, and emergence of leadership. The primary concern in this study is about the influence of group size on group performance and achievement of assembly effect bonus. Discussion of other influences may not be avoidable, however. These influences tend to be directly or indirectly related, and almost all could be related to group performance.

In 1952, Hare investigated the relationship between group size and consensus. He utilized groups with 5 and 12 members. He observed that as group size increased from 5 to 12, the degree of consensus decreased, and individual range of ideas and inputs increased.[72]

Taylor and Faust used the Twenty Questions Problem to investigate the influence of size on group quality of solution, group speed in solving problems, and group

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[72]A. P. Hare, "Interaction and Consensus in Different Sized Groups," American Sociological Review 17 (1952):269-272.

failure to solve problems. Fifteen individuals, 15 groups of two, and 15 groups of four were required to guess items on a list of 20 animal, 20 vegetable, and 20 mineral objects. Subjects would ask questions that would be answered by "yes" or "no," and on that basis, subjects were expected to solve the problem. The measures used were number of questions needed to solve a problem, time required, and correctness of solution. Problems not solved within 30 questions were designated as failures.[73]

The results indicated that there were no significant differences between groups of four and groups of two in terms of time to solve problems and in terms of number of questions asked before solving the problem. There were, however, significant differences between the two types of groups in terms of number of failures per problem. Groups of four were superior. To explain these results, they speculated that increasing the number of participants in the group reduced the probability of a persisting wrong set.[74] In other words, increasing the size of group enhances the ability of the group to correct its errors.

In 1963, Thomas and Fink reviewed experimental studies that dealt with effects of group size on various aspects of group performance (i.e., quality, speed,

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[73]D. W. Taylor and W. L. Faust, "Twenty Questions: Efficiency in Problem Solving as a Function of Size of Group," Journal of Experimental Psychology 44 (1952):360-362.

[74]Ibid., pp. 362-364, 366.

efficiency, and productivity), among other things. They concluded that:

> . . . both quality of performance and group productivity were positively correlated with group size under some conditions [i.e., proper communication and coordination mechanisms and no time pressure], and under no conditions were smaller groups superior. In contrast, measures of speed showed no difference or else favored the smaller groups.[75]

Imposing conditions of communication and coordination in the above conclusion, while understandable, may eliminate some important differences between smaller and larger groups and consequently reduce the importance of size as an influencing factor in group processes. These conditions, at least indirectly, are among the major reasons for concern about size. Larger groups, as noted by Cartwright, exhibit: a) more difficulty in achieving adequate communication among members, b) more problems of coordination, and c) greater degree of reliance upon impersonal forms of control.[76]

Nevertheless, the thrust of conclusions on the basis of Thomas and Fink's review has been corroborated by a study conducted by Cummings, Huber, and Arendt. They utilized ad hoc groups with 3, 4, and 5 members and the NASA survival problem to explore the relationships between size and solution quality and between size and problem solving

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[75]E. J. Thomas and C. F. Fink, "Effects of Group Size," Psychological Bulletin 60 (1963):373.

[76]Darwin Cartwright, "The Nature of Group Cohesiveness," 3rd ed., Group Dynamics: Research and Theory, Edited by D. Cartwright and A. Zander (New York: Harper and Row, 1968), pp. 102-103.

speed. They concluded that a) the quality of group solution increased with group size and b) the speed of solution was not influenced significantly by group size.[77]

Steiner formulated propositions about the relationship between size and potential productivity and actual productivity that took into account the nature or type of the task (i.e., disjunctive, cojunctive, and additive). Since tasks in this study are not cojunctive or additive and could be classified, though not precisely, as disjunctive, only those propositions with these types of tasks (i.e., disjunctive) will be presented.

Size and potential productivity have positive relationship with a decreasing rate. As size increases, the effect on actual productivity is more complex. The group organizational problems become more difficult to solve effectively. Coordination and communication procedures become more complex and less effective. Furthermore, motivation level is expected to be lower in larger groups. These results lead to the expectation that actual productivity will be lower as group size increases. Even if actual productivity is improved, it is not expected to be improved by the same rate potential productivity will. Therefore, Steiner expected that increase in group size would result in

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[77]L. L. Cummings, G. P. Huber, and E. Arendt, "Effects of Size and Spacial Arrangement on Group Decision Making," Academy of Management Journal 17 (1974):460-475.

increase in process loss.[78] Stated alternatively and probably more accurately, increasing size will increase group potential but at the same time will increase the probability of process loss. General empirical support for these expectations was reported by Bray et al. They found that as group size increased, especially beyond six members, actual productivity of the group fell below potential productivity.[79]

Hill argued that increasing the size of group would increase its probability of containing at least one member who could solve the problem, but at the same time, group would include a large proportion of medium- and low-ability members who may hinder performance on complex tasks.[80]

Generally speaking, the research taken together indicates that group will benefit in terms of performance when its size increases up to a certain number, after which ineffectiveness and inefficiency start to dominate. The question is what this limit (or critical size) might be? The answer is probably an empirical one. Steiner reviewed several studies that dealt with this question and found

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[78] I. D. Steiner, Group Process and Productivity, pp. 67-83.

[79] R. M. Bray, N. L. Kerr, and R. S. Atkin, "Efforts of Group Size, Problem Difficulty, and Sex on Group Performance and Member Reactions," pp. 1224-1240.

[80] G. W. Hill, "Group Versus Individual Performance:" p. 525.

this number to range from 5 to 9 members.[81] Bray et al. found that increasing group size from 6 to 10 to be counter-productive.[82] Laughlin et al. and Cummings et al. considered groups with sizes not exceeding five and concluded that size and performance have positive functional relationship.[83] So at least up to and including five members, size is positively related to group productivity.

The influence of size on the achievement of assembly effect bonus was not investigated. However, due to influences of size on interaction patterns, communication channels, and coordination mechanisms, it is expected that assembly effect bonus will decrease after some critical size, probably 5 or 6 as most research seems to suggest.

Gender Composition of Groups

There seems to be differences between males and females in various behavioral aspects. Hare, in his review, noted that: a) women tend to be superior in personal and interesting tasks, and men tend to be superior in abstract and objective tasks; b) in group work, men tend to initiate ideas and women tend to react to these ideas; and c) women

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[81] I. Steiner, Group Process and Productivity, pp. 100-102.

[82] R. M. Bray et al., "Effects of Group Size, Problem Difficulty, and Sex on Group Performance and Member Reactions," pp. 1224-1240.

[83] P. R. Laughlin et al., "Group Size, Member Ability and Social Schemes on an Intellective Task," Journal of Personality and Social Psychology 31 (1975):522-535.

tend to be more cooperative and accommodating and men tend to be more competitive, "exploitative" and win driven.[84]

Shaw, in his review, presented similar conclusions that include: a) men and women behave differently in interaction situations; b) men tend to be more aggressive while women tend to adopt a cooperative norm; c) women tend to be more talkative than men; and d) women tend to conform more than men to group norms.[85]

These differences were attributed to cultural influences and thought to have influence on other aspects of group behavior.[86] The most relevant issue in this study is the influence of gender composition of group on performance.

South investigated group performance in terms of effectiveness (accuracy) and efficiency (time of performance) on problems such as multiple choice problems and judging English composition. The most relevant part of that study to this section is his observation regarding the difference in approach between all-male groups and all-female groups. In all-male groups, each member seemed to try to figure out a solution for himself. In contrast, each member of all female groups tended to offer her suggestions and seek

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[84]P. A. Hare, Handbook of Small Group Research, pp. 201-203.

[85]M. E. Shaw, Group Dynamics: pp. 182-186.

[86]P. A. Hare, Handbook of Small Group Research, pp. 201-203; M. E. Shaw, Group Dynamics:, pp. 182-186.

others' opinions. Females tended to be more cooperative than males.[87]

Bray, Kerr, and Atkin compared the performance of all-male groups with all-female groups. They found the difference between the two types of groups in terms of performance to be insignificant.[88] A similar finding was reported in a brainstorming study conducted by Lamm and Trommsdorff in which all-male groups and all-female groups did not differ significantly in their performance.[89] In contrast to these studies, Hoffman, Harburg, and Maier used the Change of Work exercise in a relatively complex experimental design to compare mixed-sex, all-male, and all-female groups. They reached the conclusion that mixed-sex groups were more effective than all-male groups and that all-male groups were more effective than all-female groups.[90]

Wood reported a meta-analytic review of sex differences in group performance. Her major findings

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[87]Earl B. South, "Some Psychological Aspects of Committee Work," Journal of Applied Psychology 11 (1927): 437-464.

[88]R. M. Bray, N. L. Kerr, and R. S. Atkin, "Effects of Group Size, Problem Difficulty, and Sex on Group Performance and Member Reactions," Journal of Personality and Social Psychology 36 (1978):1224-1240.

[89]H. Lamm and G. Trommsdorff, "Group Versus Individual Performance on Tasks Requiring Ideational Proficiency," European Journal of Social Psychology 3 (1973):361-388.

[90]L. R. Hoffman, E. Harburg, and N.R.F. Maier, "Differences and Disagreement as Factors in Creative Group Problem Solving," Journal of Abnormal and Social Psychology 64 (1962):206-214.

were: a) all-male groups performed better than all-female groups; b) mixed-sex groups seemed to perform better than same-sex groups; and c) research on mixed-sex groups was relatively scarce.[91]

The apparent all-male group superiority relative to all-female group was attributed to differences in interaction style of men and women. These differences influence group processes which, in turn, affect productivity. Women tend to be active in social activity more than men who tend to focus more on task activity. Women's higher level of social activity may serve as a kind of general process loss that may reduce productivity. On the other hand, men's higher level of task behavior leads to better performance.[92]

In the case of mixed-sex groups versus same-sex groups, the picture is not clear due to scarcity of empirical evidence. Some have suggested that mixed-sex groups would outperform same-sex groups due to heterogeneity of abilities. Men and women bring a diversity of skills and abilities that could be applied to the task solution.[93] Others have suggested that mixed-sex groups would

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[91]W. Wood, "Meta-Analytic Review of Sex Differences in Group Performance," Psychological Bulletin 102 (1987):53-71.

[92]W. Wood, "Meta-Analytic Review of Sex Differences in Group Performance," pp. 53-55.

[93]L. R. Hoffman, "Group Problem Solving" Advances in Experimental Social Psychology, Vol. 2, Edited by L. Berkowitz (New York: Academic Press, 1965), pp. 99-132, cited by W. Wood, "Meta-Analytic Review of Sex Differences in Group Performance," p. 55.

outperform same-sex groups due to heterogeneity of interaction styles. Mixing men and women equip the group with complementary abilities that enable the group to be effective at task demands and socio-emotional demands of the situation.[94]

Hare, on the other hand, suggested that same-sex groups may generally perform better than mixed-sex groups because same-sex groups spend less time in socio-emotional activities and more time in task activities.[95]

Empirically, the evidence favors men's superiority in terms of performance in the case of same-sex group comparisons. In case of mixed-sex groups, Wood was able to locate only 13 studies that dealt with this issue. She found that mixed-sex groups seem to perform better than same-sex groups, even though appropriate levels of significance were seldom reached.[96]

On the basis of the previous brief review, the following conclusions were drawn:

1. Most studies dealt with one-sex groups rather than mixed-sex groups.

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[94]W. Wood, "Meta-Analytic Review of Sex Differences in Group Performance," p. 68.

[95]P. A. Hare, Handbook of Small Group Research, pp.

[96]Both Shaw (1981) and Hare (1976) presented a good review of empirical results and good bibliographies of studies dealing with these issues. Wood (1987) reported a meta-analytic study covering 52 studies in the area of sex versus performance and an excellent list of studies dealing with this issue.

2. Generally, in the case of all-male/all-female group comparisons, all-male groups seemed to be more effective.

3. Studies on mixed-sex groups, albeit few, seem to indicate superiority of mixed-sex groups over same-sex groups

4. Explanations of mixed-sex groups' superiority include diversity of abilities and skills and diversity in interaction styles.

5. Differences between sexes are largely attributed to cultural influences.

The last conclusion above implies that conclusions about sex influence in group performance may not hold across time and across cultures. The fourth conclusion above (i.e., superiority is due to heterogeneity) makes plausible the preliminary proposition, or at least expectation, that groups which are relatively more mixed in terms of sex are more effective than groups which are relatively less mixed.

Most studies in this area compared groups to groups under different conditions of gender composition. The influence of gender composition on the difference between group performance and best member performance is not well explored, if at all. Any conclusions about this influence is probably speculative, and the issue is better left to be determined empirically. This study should contribute in this regard.

Group Maturity

Maturity is thought to be one of the conditions under which groups perform more effectively (i.e., achieve

assembly effect bonus). It refers to the sociopsychological state of the group relevant to its ability to resolve interpersonal problems and overcome obstacles to valid communication and coordination and, consequently, its abilities to achieve consensus. More mature groups are those that have acquired abilities and skills to build effective interpersonal relations. These abilities and skills require time to develop.[97] A group, along the span of its life, acquires and polishes these abilities and skills so that most of its energy is devoted to productivity and meeting task demands.

Little attention has been given to the issue of group maturity and its influences on group performance and group achievement of assembly effect bonus. Only the few studies that compared ad hoc and established groups could be considered to have dealt at least indirectly with this issue. Unfortunately, the results were mixed and inconclusive. Hall and Williams in 1966 found, as expected, the established groups (groups with higher level of maturity) to be more effective than ad hoc groups (groups without maturity). Ford, Nemiroff, and Pasmore found the opposite to be the case. In a 1970 study, Hall and Williams found

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[97]B. E. Collins and H. Guetzkow, A Social Psychology of Group Processes for Decision Making, pp. 58-68; W. G. Bennis and H. A. Shepard, "A Theory of Group Development," Human Relations 9 (1956):415-437.

the difference to be insignificant regardless of group maturity.[98]

Maturity is not the only difference between ad hoc and established groups. Established groups (with low level of maturity) even at the time of establishment have expectations about future relations, interactions, and achievements that may not exist in the case of ad hoc groups.[99] Investigating group performance across time or longitudinally is probably more desirable and is the strategy followed in this study. It may account for these expectations in addition to maturity and may remove some of the doubts that ad hoc and established groups operate basically according to different principles.[100] The expectation is that groups relative to individuals will improve over time as maturity improves.

In short, group maturity is thought to have important influence on group performance. Research activities in this area are very limited, available evidence is mixed and inconclusive, and almost all studies considered this issue by contrasting ad hoc and established groups. The

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[98]J. Hall and M. S. Williams, "Group Dynamics Training and Improved Decision Making," pp. 27-32; J. Hall and M. S. Williams, "A Comparison of Decision-Making Performances in Established and Ad Hoc Groups," pp. 214-222; D. L. Ford, P. M. Nemiroff and W. A. Pasmore," Group Decision-Making Performance as Influenced by Group Tradition," pp. 223-228.

[99]M. E. Shaw, Group Dynamics:, p. 447.

[100]Ibid., p. 447; I. Lorge, D. Fox, J. Davitz, and M. Brenner, "A Survey of Studies Contrasting the Quality of Group Performance and Individual Performance," pp. 338-370.

contribution of this study is probably related to all of these areas. It considers theoretically important factor (i.e., group maturity), it adds to available evidence, and it provides some methodological diversity.

Summary

The above review of selected literature taken as a whole indicates the following.

1. Group effectiveness in decision making and problem solving has been at least implicitly emphasized by anecdotal evidence and various management and leadership theories.

2. In the area of individual versus group performance paradigm, both process loss and assembly effect bonus have been suggested.

3. Empirical evidence for group superiority is mixed and in most cases contradicts conventional thinking.

4. The use of ad hoc groups and "trivial" problems in research is suspicious. Research efforts are frequently criticized on these bases.

5. Group maturity is probably a significant, yet ignored, factor in individual versus group research. Mature groups are probably more able to achieve assembly effect bonus than less matured groups.

6. Group size is related to group inventory of abilities and skills and group interaction effectiveness and efficiency. Size is probably positively related to

group performance up to a certain critical point, probably 5 or 6.

7. Gender composition of the group is probably related to group performance. Groups that are more mixed in terms of sex are probably more able to achieve assembly effect bonus than groups which are less mixed.

8. The influence of gender composition on the group ability or disability to achieve assembly effect bonus is not known with any confidence, if at all.

This review of the literature provided the background for this study. Chapter III will contain the procedures followed in carrying out this study.

CHAPTER III

PROCEDURE OF THE STUDY

Introduction

The purpose of this study is to empirically explore group achievement of assembly effect bonus under certain conditions of group maturity, group size, and group gender composition. In this chapter, procedures and techniques that have been implemented to produce the relevant data for answering the basic research questions of this study are described. Also, the measures of basic concepts considered in this study and the statistical techniques that have been used in data analyses and hypotheses testing are outlined and explained.

For the convenience of the reader, the research questions are restated again.

Research Questions

1. Does group maturity increase the probability that groups will outperform their best member (i.e., achieve assembly effect bonus)?

2. Does group composition in terms of gender influence significantly the probability that groups will outperform their best member?

3. Does group size influence significantly the probability that groups will outperform their best member?

Population

The population for this study was comprised of members of 220 Team Learning Groups[1] whose total members were 1,320 individuals of whom 822 were males and 498 were females. Members of these groups were participants in organizational behavior courses taught at two major universities in the United States and extension programs in foreign countries, including Korea, Panama, and Saudi Arabia, and participants of a management development program in a large Midwestern manufacturing plant.

Design of Study

Dr. Larry K. Michaelsen and others[2] developed and applied Team Learning Instructional Format. Application

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[1]L. K. Michaelsen, W. Watson, J. P. Cragin, and L. D. Fink, "Team Learning: A Potential Solution to the Problems of Large Classes," Exchange: The Organizational Behavior Teaching Journal 7 (1982):13-22.

[2]L. K. Michaelsen, W. Watson, J. P. Gragin, and L. D. Fink, "Team Learning: A Potential Solution to the Problems of Large Classes," Exchange: The Organizational Behavior Teaching Journal 7 (1982):13-22; L. K. Michaelsen, W. Watson, and C. B. Schraeder, "Informative Testing--A Practical Approach for Tutoring with Groups," The Organizational Behavior Teaching Review 9 (1985):81-83.

of this technique resulted, among other things, in the collection of data used in this study.

The application of Team Learning Instructional Format included forming groups, making decisions on performance evaluation and grading, and putting in motion sequences of major instructional activities.

Forming Groups

Individuals were randomly assigned to "permanent" groups after the class had been stratified on the basis of work experience, educational, and cultural background. The procedure consisted of:

1. obtaining background information from each student;
2. determining appropriate skill mix on the basis of background information; and
3. assigning individuals to groups so that groups were as heterogeneous as possible on the basis of background.

All of these steps were always carried out by the instructor.

Once groups were formed, the next step was to make decisions on grading and performance evaluation.

Evaluation and Grading

Grades were determined by scores in three areas: 1) individual performance, 2) group performance, and 3) group maintenance. Within each of these areas, graded assignments were as follows:

1. Individual Performance
   a. Mini-tests
   b. Final exam (application exam)

2. Group Performance
   a. Mini-tests
   b. Organizational structure, critique, and exam
   c. Application exam

3. Group Maintenance
   a. Peer evaluation

As soon as groups were formed, the class was asked to make decisions on two areas:

1. the percentage of the grade that will be determined by scores in each of the major performance areas (individual performance, group performance, and group maintenance); and

2. the relative weight of mini-tests versus final exam within individual performance. These decisions were made according to the following procedures:

   a. Groups made preliminary weights for each area and selected a member to meet with representative of other groups.

   b. Representatives assemble in the center of the classroom and discuss until a consensus about the desired grade weights was reached. NOTE: The only limitations on grade weights were that 1) a minimum of 10% must be assigned to each major area, and 2) at least 50% of the individual performance grade must be determined by the major exam.

At the end of these procedures, individuals and groups were set for instructional activities.

Instructional Activities

Each group in this study has participated in six instructional units. Each unit consisted of the following sequence of instructional activities:

individual study --> individual test --> group discussion and test --> instructor input --> application-oriented activities.

Individual tests and group tests administered at the beginning of each of these instructional units were identical. The scores on the these tests provided measures of individual performance and group performance for this study. Other activities in these instructional units, while essential for teaching, learning, and group development, were not directly relevant to measurements and analyses required for this study.

Sources of Data

Three sources were utilized in obtaining relevant data for exploring the influences of maturity, sex, and size on best member performance versus group performance:

1. mini-exams administered in the first two and last two instructional units to provide performance measures;
2. groups and individual profile records to provide data on size and gender;
3. temporal sequence of major instructional units to provide an indicator of group maturity.

These three sources require further examination.

Measures of Performance and Maturity

Measures of performance were provided by individual and group scores on the informative tests (minitests) administered at the beginning of each major instructional unit. These tests were given at the beginning of

instructional units to provide a stimulus for and an assessment of students' individual preparation and as a mechanism for identifying areas of further clarification that might be required in the instructor input stage of the sequence.[3]

The tests were objective in nature. They consisted of 12 to 18 multiple choice and true/false questions covering assigned reading material. Test questions, as evaluated by Dr. Larry K. Michaelsen who formed and administered most of them, were approximately 40% recall, 40% application, and 20% integration/inference.[4]

The procedure of administering these tests and obtaining measures of performance was as follows:

1. At the beginning of each major instructional unit, each member took individually a test on the assigned reading material.
2. As soon as all members of a group turned in their answer sheet, they were given an additional answer sheet on which they as a group immediately retook the same test.
3. Scores were computed and provided for the participants. Then, other activities would start.

While there are six measures of performance (scores on mini-tests) for each individual and each group, the first two, the middle two, and the last two are combined to

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[3]L. K. Michaelsen, W. E. Watson, and R. K. Black, "A Realistic Test of Individual Versus Group Consensus Decision Making," The Journal of Applied Psychology 74 (1989):834-839.

[4]Ibid.

obtain three measures for the purposes of this study. The total of the first two is expected to reflect the performance at lower level of maturity, the total of the second two is expected to reflect performance at medium level of maturity, and the total of the last two is expected to reflect performance at higher level of maturity. Communication, coordination, and social interactions are expected to improve in effectiveness and efficiency with time and experience. Therefore, the performance on the first two tests, the performance on the middle two tests, and the performance on the last two tests, as compared with each other, should reflect the influence, if any, of maturity on group versus best member performances.

Size and Gender

Measures of size and gender were obtained from the record of each group. Table 1 shows ranges of group sizes, number of groups with each size, and the percentage of these groups relative to the total. For the purpose of investigating the influence of size, groups with sizes of 2, 3, and 4 will be combined and groups with sizes of 7 and 8 will also be lumped together. The reason for this attempt was the low number of groups with sizes of 2, 3, 4, and 8.

Research on the influence of gender usually compares all-male groups to all-female groups or one-sex groups to mixed-sex groups. The data for this study consist mostly

TABLE 1

SIZE, NUMBER OF GROUPS, AND PERCENTAGES

Size	No. of Groups	%
2, 3, & 4	9	4.1
5	41	18.6
6	108	49.1
7 & 8	62	28.2

of mixed-sex groups, and all one-sex groups are all-male groups. With that in mind and for the purposes of investigating the influence of gender on performance, gender composition of groups will be taken as the ratio of female to total members in each group. On the basis of this ratio, five categories of groups were identified. Any group that has only one female member and more than one male member will be called "token female group." Any group with only one male member and more than one female member will be called "token male group." Any group with equal member of males and females will be called "balanced group." Any group with more male members than female members and that is not token female group will be called "majority male group." The group with more females than male members but not token male group will be called "majority female group." Table 2 shows these five categories of groups, number of groups within each category, and percentages.

TABLE 2

GENDER COMPOSITION, NUMBER OF GROUPS, AND PERCENTAGES

Gender Composition	No. of Groups	Percentage
All Male	27	12.3
Token Female	43	19.5
Majority Male	57	25.9
Balanced	38	17.3
Majority Female	41	18.6
Token Male	14	6.4

Statistical Techniques Used

To investigate the research questions of this study, several statistical techniques are used. Some techniques are used to directly explore the specifics of each of the research questions. Other techniques are used to conduct post-hoc analyses to add specificity to the results.

The main dependent variable in all of the three research questions is the difference in performance measures between group and best member. However, effects on this variable are not the only ones considered. The effects on group performance and best member performance are considered as well. Not withstanding the importance of these effects on their own, they are considered for their potential value in developing a better understanding of effects on the main dependent variable, namely the difference between the two performances.

The statistical techniques used are repeated measure analysis of variance to examine the first research question, standard one-way analysis of variance, and the Tukey test to examine the other two research questions.

Repeated measure analysis of variance is appropriate when treatments (i.e., mini-tests) are administered on the same subjects repeatedly such as the case addressed in research question No. 1 (i.e., the influence of maturity on performance). In a case such as this, observations on the same subjects will tend to be correlated.[5] The procedure followed in repeated measures ANOVA is similar to that in standard ANOVA with the exception of "the selection and calculation of the appropriate error term for a particular source of variance or comparison."[6] This different procedure of selection and calculation of the error term reduces biases due to correlation between observations on the same subject. The effect is basically to require at a certain level of confidence, for example 0.05, higher F value for the results to be significant.

Another problem in repeated measures designs that needs to be avoided is the possibility of violating the assumption of homogeneity of variances and covariances.

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[5]B. J. Winer, Statistical Principles in Experimental Design, 2nd ed. (New York: McGraw-Hill, 1971), pp. 105-106.

[6]G. Kepple, Design and Analysis: A Researcher's Handbook (Englewood Cliffs, NJ: Prentice-Hall, 1973), pp. 393-394.

Usually the F test is robust when this assumption is violated, but not in a design having correlated observations. In this case, F test will tend to be positively bias.[7]

For the case where variances and covariances are heterogeneous, an approximate test may be made by using the usual F statistic, but the degrees of freedom are adjusted by a number which depends upon the degree of heterogeneity of the variances and covariances and ranges from 0 to 1 where unity indicates that the assumption of homogeneity is met.[8]

In this study, where SAS is used as the tool for calculation, this number indicating the degrees of homogeneity is labeled Greenhouse-Geisser Epsilon and reported at the bottom of each table of results in which its application is appropriate. Its effect appears in reporting adjusted p value in addition to the usual p value. When Greenhouse-Geisser Epsilon is equal to 1, adjusted p value and usual p value are exactly the same. The smaller the adjustment index tends to be, the greater the difference between the two p values will be.

Repeated measures ANOVA is used to achieve two results. First is to find out the significance of overall effect of maturity on: (1) the difference between group

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[7]B. J. Winer, Statistical Principles in Experimental Design, p. 123.

[8]Ibid.

performance and best member performance, (2) group performance, and (3) best member performance. Second, in the case of group for example, is to make comparisons between group performance at lower maturity and medium maturity, group performance at medium maturity and higher maturity, and group performance at lower maturity and higher maturity. Similar comparisons are carried out for the other two cases. These comparisons enable us to add specificity to the overall effect and to enable us to locate sources, if any, of the overall main effect of maturity.

The second research question (effect of gender composition) and the third research question (effect of size) are analyzed by two techniques. First is the standard one-way analysis of variance. This technique provides an overall F statistic which is used to determine the overall significance of a factor's effect on each of the three dependent variables. It will not, however, enable us to be more specific than that. In other words, it will not be possible to locate the source of the significant difference, if any. Therefore, post-hoc analyses are performed whenever a significant overall F test in the analysis of variance is obtained.

Post-hoc analyses involve the application of Tukey test which is recommended when various simple pairwise differences are considered such as the case in this study. Tukey test is conservative as far as Type I error (false

rejection of the null hypothesis) is concerned.[9] Also, at least under SAS procedure, it is appropriate for unequal sample sizes.[10] At certain levels of significance, for example $p < 0.05$, the Tukey test is helpful to determine whether the difference between any two levels of a factor is significant or not.

In short, analyses of variance and Tukey test are sufficient to determine whether group performance, best member performance, or, more importantly, the difference between the two changes significantly in the overall and across categories of gender composition and categories of group size.

Finally, two statistical measures are reported whenever appropriate. The first is the R^2 which indicates the amount of variation in the dependent variable explained by the independent variable. This measure is reported whenever overall results of ANOVA are significant. The factors considered in this study are expected to explain or indicate only little of the overall changes in group performance, best member performance, and the difference between the two. Reporting amounts of variation explained should help put the result in a better and more objective perspective.

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[9]G. Kepple, Design and Analysis:, pp. 155-157; B. J. Winer, Statistical Principles in Experimental Design, pp. 197-198.

[10]SAS User's Guide: Statistics, Version 5 ed. (Cary, NC: SAS Institute, Inc., 1985), p. 473.

The second statistical measure is the test of power of the test statistics when that test statistic (i.e., F statistic) is not significant. Simply stated, ". . . power is interpreted as the probability of making a correct decision when the null hypothesis is false."[11] Power helps in determining the sensitivity of the experiment in detecting treatment effects. In the presence of a nonsignificant F test, the decision is not to reject the null hypothesis (e.g., not treatment effect). Higher power (> 0.70) helps us put more confidence in that decision. Conversely, low power (< 0.40) raises concerns as to the correctness of that decision and raises doubts as to sensitivity of the experimental manipulations in producing the hypothesized effect and suggests other courses of action such as replication and incorporation of refinements and changes in the design or tools of measurement.[12]

In this study, the formula used to calculate the test of power is the one suggested in 1968 by Kirk and reported in 1973 by Keppel.[13] [For the formula and other details, see cited publications.]

The steps described above and the sequence of statistical techniques used are summarized in Table 3.

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[11]G. Keppel, Design and Analysis, p. 525.

[12]Ibid., pp. 525-535.

[13]R. E. Kirk, Experimental Design: Procedures for the Behavioral Sciences, cited by G. Keppel, Design and Analysis:, pp. 534-536.

TABLE 3

STATISTICAL TECHNIQUES USED: A SUMMARY OF SEQUENCE AND PROCEDURES

Step (Purpose)	Factor(s)*	Statistical Techniques
First (Research Question 1)	Maturity	Repeated Measures ANOVA Repeated Measures ANOVA Profile Comparisons of Means
Second (Research Question 2)	Gender	One-way ANOVA Tukey Test One-way ANOVA by Maturity Tukey Test by Maturity
Third (Research Question 3)	Size	One-way ANOVA Tukey Test One-way ANOVA by Maturity Tukey Test by Maturity

*Dependent variables are group performance, best member performance, and the difference between the two.

CHAPTER IV

RESULTS OF THE STUDY

Introduction

This chapter reports the results of statistical techniques used to explore the research questions of this study. They are presented under the following headings: Effect of Maturity, Effect of Gender Composition, and Effect of Size.

Effect of Maturity

Results reported in this section pertain to the effect of maturity on: a) group performance, b) best member performance, and c) difference in performance. Also included are the results of post-hoc analysis to pinpoint the location of significant main effects, if any.

Effect of Maturity on the Difference between Group and Best Member Performances

As shown in Table 4, repeated measures ANOVA yields that, at the 0.05 level, there is no significant main effect of maturity on the difference between group performance and best member performance. Since the overall effect is not significant, further specific comparisons among the

various levels of maturity are not expected to yield significantly meaningful results. Nevertheless, the results of these comparisons are reported in a summarized fashion in Table 5 for the reader's observation. As can be seen, none of the contrasts is significant at the 0.05 level.

TABLE 4

REPEATED MEASURES ANOVA TEST OF THE EFFECT OF MATURITY ON THE DIFFERENCE BETWEEN GROUP PERFORMANCE AND BEST MEMBER PERFORMANCE

Source	D.F.	Sum of Sq.	Mean Sq.	F	p	Adjusted p
Maturity	2	122.022	61.011	0.39	0.674	0.671
Error (Maturity)	438	67741.811	154.662			

Greenhouse-Geisser Epsilon = 0.9842

TABLE 5

SUMMARY OF THE REPEATED MEASURES ANOVA CONTRASTS OF THE DIFFERENCE BETWEEN GROUP PERFORMANCE AND BEST MEMBER PERFORMANCE BY MATURITY

Contrast*	D.F.	F	p Value
D_2-D_1	1,219	0.53	0.465
D_3-D_2	1,219	0.02	0.887
D_3-D_1	1,219	0.62	0.430

*D_1, D_2, and D_3 denote the difference in performance between group and best member at lower, medium, and higher level of maturity, consecutively.

Effect of Maturity on Group Performance

In exploring the effect of maturity on group performance, the following results are obtained:

1. As shown in Table 6, repeated measures ANOVA test yields, at the 0.05 level, a significant main effect of maturity on group performance.

TABLE 6

REPEATED MEASURES ANOVA TEST OF THE EFFECT OF MATURITY ON GROUP PERFORMANCE

Source	D.F.	Sum of Sq.	Mean Sq.	F	p	Adjusted p
Maturity	2	9844.238	4922.119	34.61	0.000	0.000
Error	438	62291.483	142.218			

Greenhouse-Geisser Epsilon = 0.9768

2. As shown in Table 7, repeated measures ANOVA comparisons indicate that: 1) groups at medium level of maturity significantly outperformed groups at lower level of maturity ($p < 0.0001$); 2) groups at higher level of maturity significantly outperformed groups at medium level of maturity ($p < 0.012$); and 3) groups at higher level of maturity significantly outperformed groups at lower level of maturity ($p < 0.0001$).

TABLE 7

REPEATED MEASURES ANOVA CONTRASTS OF GROUP PERFORMANCES BY MATURITY

ontrast*	Source	D.F.	Sum of Sq.	Mean Sq.	F	p
G_2-G_1	Mean	1	8954.968	8954.968	27.36	0.000
	Error	219	7166.292	327.243		
G_3-G_2	Mean	1	1798.368	1798.368	6.63	0.012
	Error	219	59359.192	271.647		
G_3-G_1	Mean	1	18779.376	18779.376	73.64	0.000
	Error	219	55849.024	255.018		

*G_1 = Group performance at lower level of maturity
G_2 = Group performance at medium level of maturity
G_3 = Group performance at higher level of maturity

Effect of Maturity on Best Member Performance

The analyses of the effect of maturity on best member performance led to the following results:

1. Repeated measures analysis of variance, as shown in Table 8, indicate thats there is a significant main effect of maturity on best member performance ($p < 0.0001$).

TABLE 8

REPEATED MEASURES ANOVA TEST OF THE EFFECT OF MATURITY ON BEST MEMBER PERFORMANCE

Source	D.F.	Sum of Sq.	Mean Sq.	F	p	Adjusted p
Maturity	2	7797.375	3898.687	28.86	0.000	0.000
Error (Maturity)	438	59176.232	135			

Greenhouse-Geisser Epsilon = 0.9838

2. Comparisons between pairs of means indicate as shown in Table 9: 1) best member performance at medium level of maturity significantly exceeds that at lower level of maturity ($p < 0.0001$); 2) best member performance at higher level of maturity significantly exceeds that at medium level of maturity ($p < 0.018$); and 3) best member performance at higher level of maturity significantly exceeds that at lower level of maturity ($p < 0.0001$).

TABLE 9

REPEATED MEASURES ANOVA CONTRASTS OF BEST MEMBER PERFORMANCE BY MATURITY

Contrast*	Source	D.F.	Sum of Sq.	Mean Sq.	F	p
BM_2-BM_1	Mean	1	6812.117	6812.117	28.82	0.000
	Error	219	51759.564	236.345		
BM_3-BM_2	Mean	1	1591.404	1591.404	5.67	0.018
	Error	219	61426.846	280.488		
BM_3-BM_1	Mean	1	14988.603	14988.603	51.02	0.000
	Error	219	64342.286	293.800		

*BM_1 = Best member performance at lower maturity
BM_2 = Best member performance at medium maturity
BM_3 = Best member performance at higher maturity

Effect of Gender Composition

The results reported in this section are relevant to exploring and hopefully answering research question No. 2. Similar to the previous section, results are reported in three sections: Effect on the Difference in Performance, Effect on Group Performance, and Effect on Best Member Performance.

Effect of Gender Composition on the Difference Between Group Performance and Best Member Performance

One-way analysis of variance (Table 10) shows that at 0.05 level there is no significant effect of gender composition on the difference between group performance and best member performance. It seems that groups with different gender composition are not significantly different from each other in their performances relative to the performances of their best members. The power of the F statistic is approximately 0.40 which is low enough to raise concerns about the value of this result. The nonsignificant F is probably more due to insensitivity of the experiment rather than lack of the existence of the phenomena.

TABLE 10

ANOVA TEST OF DIFFERENCES IN PERFORMANCE BY GENDER COMPOSITION

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio*	Significance
Between	5	1041.543	208.309	1.27	0.277
Within	654	107694.145	164.669		
Total	659	108735.688			

*Power of the F statistic = 0.40.

The analysis of variance above were carried out on the total data and irrespective of level of maturity. Further analyses of variance were carried out at each level of maturity. As shown in the summary of these results (Table

11), the effect of gender composition on the difference between performances is not significant at any of the levels of maturity considered in this study.

TABLE 11

SUMMARY OF ANOVA TEST OF DIFFERENCES IN PERFORMANCE BY GENDER COMPOSITION AT EACH LEVEL OF MATURITY

	Maturity		
	Lower	Medium	Higher
F Value	0.66	1.44	1.59
D.F.	5,214	5,214	5,214
Significance	0.653	0.210	0.165

Effect of Gender Composition on Group Performance

In exploring the effect that gender composition may have on group performance, the following results were obtained:

1. Analysis of variance (Table 12) yields that there is a significant effect of gender composition on group performance at $p < 0.05$ with only 2.6% of the variation explained as indicated by R^2.

TABLE 12

ANOVA TEST OF GROUP PERFORMANCE BY GENDER COMPOSITION

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio*	Significance
Between	5	3752.923	750.585	3.48	0.004
Within	654	141046.499	215.667		
Total	659	144799.421			

*$R^2 = 0.026$

2. Tukey test (Table 13) reveals that at $p < 0.05$: a) mostly female groups significantly outperformed balanced groups, b) all-male groups significantly outperformed balanced groups, and c) all other pairwise comparisons did not yield any significant results.

TABLE 13

TUKEY TEST OF GROUP PERFORMANCE BY GENDER COMPOSITION

	Gender Composition					
	Balanced	Token Female	Majority Male	Token Male	Majority Female	All Male
Means	175.639	179.649	179.814	180.816	182.621	182.191
Balanced = 175.639	-	4.010	4.175	5.177	6.982*	7.280*
Token Fem. = 179.649		-	0.164	1.167	2.972	3.270
Majority Male 179.814 =			-	1.003	2.808	3.106
Token Male = 180.816				-	1.805	2.103
Majority Fem. 182.621 =					-	0.298
All Male = 182.191						-

Critical value of studentized range = 3.322

*Significant at $p < 0.05$.

3. As summarized in Table 14, analysis of variance at each level of maturity shows that there is a significant effect of gender composition on group performance at lower maturity and medium maturity but not at higher maturity.

The differences between groups that are due to gender composition seem to diminish over time.

TABLE 14

SUMMARY OF ANOVA TEST OF GROUP PERFORMANCE BY GENDER COMPOSITION AT EACH LEVEL OF MATURITY

	Maturity		
	Lower	Medium	Higher
F Value	3.35	2.55	1.10
D.F.	5.214	5,214	5,214
Significance	0.006	0.028	0.362

Tukey test to follow-up on the step above yields, at $p < 0.05$, significant differences only at lower level of maturity. At that time, all male groups significantly outscored balanced groups, and majority female groups significantly outscored balanced groups. No significant differences are found elsewhere.

Effect of Gender Composition on Best Member Performance

As shown in Table 15, analysis of variance failed to show, at $p < 0.05$, any significant effect of gender composition of the groups on the performance of the best member. However, the significance of this effect may not be remote since it can be found at only $p < 0.053$. But, with test power of approximately 0.42, the correctness of this result is doubtful. The study may not have been sensitive enough to detect the proposed effect.

TABLE 15

ANOVA TEST OF BEST MEMBER PERFORMANCE
BY GENDER COMPOSITION OF THE GROUP

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio*	Significance
Between	5	2565.737	513.147	2.20	0.053
Within	654	15246.493	233.123		
Total	659	155028.229			

*Power of the F statistic = 0.42.

The post-hoc and follow-up analysis (i.e., Tukey test and ANOVA at each level of maturity with Tukey tests) did not yield any significant results and, therefore, were not reported.

Effect of Group Size

This section contains results relevant to Research Question 3. Similar to previous sections, we will explore the effect of groups size on: a) the difference between group performance and best member performance, b) group performance, and c) best member performance.

Effect of Group Size on the Difference Between Group Performance and Best Member Performance

As shown in Table 16, analysis of variance shows, although barely, that size has no significant effect on the difference between groups performance and best member performance. However, with a test power of only 0.40, falsely accepting that size has no effect in this case is highly probable.

TABLE 16

ANOVA TEST OF DIFFERENCES IN PERFORMANCE BY GROUP SIZE

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio*	Significance
Between	3	1273.153	424.384	2.59	0.052
Within	656	107462.535	163.814		
Total	659	108735.687			

*Power of F statistic = 0.40.

Due to lack of significance in the standard analysis of variance, Tukey test was not applied. Analysis of variance at each level of groups maturity did not reveal any significant effects and, therefore, not reported.

Effect of Group Size on Group Performance

As shown in Table 17, group performance is significantly influenced by group size, with size explaining 2.4% of the variation.

TABLE 17

ANOVA TEST OF GROUP PERFORMANCE BY GROUP SIZE

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio*	Significance
Between	3	3526.572	1175.524	5.46	0.001
Within	656	141272.849	215.355		
Total	559	144799.421			

*R^2 = 0.024

Tukey test shows that at $p < 0.05$ groups with size of 5 significantly outscored groups with size of 6. Other comparisons were not significant (Table 18).

TABLE 18

TUKEY TEST OF GROUP PERFORMANCE BY GROUP SIZE

	Size			
Means	6 177.825	7 & 8 181.261	5 182.870	2, 3, & 4 185.037
6 = 177.827	-	3.437	5.045*	7.212
7 & 8 = 181.1261		-	1.609	3.775
5 = 182.870			-	2.116
2,3&4 = 185.037				-

*Significant at $p < 0.05$

Results of analysis of variance at each level of maturity are summarized in Table 19. The influence of size on group performance is significant only when the group is at medium level of maturity. At that time, groups of size 7 outperformed significantly those of size 6. No other significant differences seem to exist, as indicated by the Tukey test.

TABLE 19

SUMMARY OF THE RESULTS OF ANOVA TEST OF GROUP PERFORMANCE BY SIZE AT EACH LEVEL OF MATURITY

	Maturity		
	Lower	Medium	Higher
F Value	2.04	4.32	0.77
D.F.	3,216	3,216	3,216
Significance	0.109	0.005	0.511

Effect of Group Size on Best Member Performance

As shown in Table 20, best member performance is not significantly influenced by group size. In addition to that, analysis of variance does not show any significant effect of size on best member performance at any level of group maturity (at lower maturity, $F = 0.2$, d.f. = 3,216, $p < 0.666$; and at higher maturity, $F = 0.76$, d.f. = 3,216, $p < 0.518$). In short, at least as far as this data is concerned, best member performance appears to be independent of group size. However, one should be informed that F statistic of the main effect has a power of less than 0.30. The lack of significant effect of size may be due to other aspects that may cause the study to be insensitive enough to detect the effect.

TABLE 20

ANOVA TEST OF BEST MEMBER PERFORMANCE BY GROUP SIZE

Source	D.F.	Sum of Sq.	Mean Sq.	F Ratio*	Significance
Between	3	801.547	267.183	1.14	0.334
Within	656	154226.681	235.102		
Total	659	155028.229			

*Power of test < 0.30.

CHAPTER V

SUMMARY, CONCLUSIONS, AND DISCUSSION

Introduction

In the first section of this chapter, purpose, procedures, and findings are summarized. Conclusions about the three basic research questions and their derivatives are presented in the second section. Finally, discussions and recommendations for future studies are presented.

Summary of Purpose, Procedures and Findings

The purpose of this study was to explore empirically the achievement of process loss/gain under conditions of group maturity, group gender composition, and group size. Subjects were members of 220 team learning groups[1] who participated in organization behavior courses taught over a

[1]L. K. Michaelsen et al., "Team Learning: A Potential Solution to the Problems of Large Classes," Exchange: The Organizational Behavior Teaching Journal 7 (1980):13-22; L. K. Michaelsen et al., "Informative Testing--A Practical Approach for Tutoring with Groups," The Organizational Behavior Teaching Review 9 (1985):81-83.

five-year period. The Team Learning instructional format[2] followed in training subjects consisted of elaborate procedures and steps (Chapter III) that included taking six mini-informative tests. The scores on these tests were used as measures of best member performance and group performance. The difference between these two performances was the basic "dependent variable." Performances at lower level maturity were indicated by the sum of scores on the first two tests, at medium level maturity by the sum of scores on the second two tests, and at higher level maturity by the sum on the last two tests. Measures of group size and gender composition were obtained from the record of each group. Groups were categorized in terms of gender composition to be all-male, token-female, majority-male, balanced, token-male, or majority-female on the basis of the ratio of females to males in each group.

The essential statistical tools used to explore each of the research questions were one-way analysis of variance, Tukey test, and repeated measures ANOVA. In addition to exploring the effects on the <u>difference</u> between group performance and best member performance, analyses were extended to include effects on group performance and best member performance.

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[2]L. K. Michaelsen et al., "Informative Testing--A Practical approach for Tutoring with Groups."

The results of the statistical analyses on the influence of maturity indicate that, although both group and best member are significantly affected, there is no evidence to indicate the existence of either assembly effect bonus or process loss. There is no significant difference between group performance and best member performance regardless of group maturity.

Similarly, at least as these data are concerned, group gender composition does not seem to have any significant effect on best member performance and on the difference between group performance and best member performance. There is, however, a significant influence on group performance. All-male and majority female groups significantly outperformed balanced groups.

The statistical analyses of the influence of group size on the difference between group performance and best member performance are not significant. The influence on group performance is significant at 0.05 level, with groups of size 5 significantly outperforming those of size 6. Finally, at least as these data are concerned, best member performance seems to be "independent" of group size.

Conclusions and Discussion

The following conclusions are based on the findings from Chapter IV and correspond to the research questions reported in Chapter I.

Research Question 1: Does group maturity increase the probability that groups will outperform their best member (i.e., achieve assembly effect bonus)?

At the 0.05 level of confidence, there is no evidence to show that maturity plays a significant role on a group's ability to outperform their best member. Furthermore, there is no evidence to indicate that best members outperformed their groups. In other words, the evidence is not indicative of either the existence of assembly effect bonus or the existence of process loss as commonly operationalized. This finding contradicts the studies by Watson (1928), Yuker (1955), and Hall and Williams (1970) which showed the achievement of assembly effect bonus.[3] Also, this finding contradicts the studies by Marquart (1955), Graham (1977), Harari et al. (1975), Nemiroff et al.

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[3]G. B. Watson, "Do Groups Think More Efficiently than Individuals?" Journal of Abnormal and Social Psychology 23 (1928):228-336; H. E. Yuker, "Group Atmosphere and Memory," Journal of Abnormal and Social Psychology 51 (1955):17-23; J. Hall and M. S. Williams, "Group Dynamics Training and Improved Decision Making," The Journal of Applied Behavioral Sciences 6 (1970):39-68.

(1976), Miner (1984), Campbell (1968), and Yetton et al. (1982) that indicated the existence of process loss.[4]

This finding is better understood by considering separately the influence of maturity on group performance and best member performance. Group performance is significantly influenced by level of maturity. At the 0.05 level of confidence, group performance improved significantly over time. Groups at higher level of maturity significantly outperformed those at lower and medium level of maturity, and groups at medium level of maturity significantly outperformed those at lower level of maturity. The effect on best member performance is similar in every case.

The finding that group performance improved significantly over time supports the study by Hall and Williams (1966) and contradicts the findings by Ford et al.

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[4]D. I, Marquart, "Group Problem Solving," Journal of Social Psychology 41 (1955):103-113; J. P. Campbell, "Individual Versus Group Problem Solving in an Industrial Sample," Journal of Applied Psychology 52 (1968):205-210; O. Harari and W. K. Graham, "Tasks and Task Consequences as Factors in Individual and Group Brainstorming," The Journal of Social Psychology 95 (1975):61-65; P. M. Nemiroff et al., "The Effects of Two Normative Structural Interventions on Established and Ad Hoc Groups: Implications for Improving Decision Making Effectiveness," Decision Sciences 7 (1976):841-855; P. W. Yetton and P. C. Bottger, "Individual vs. Group Problem Solving: An Empirical Test of a Best Member Strategy," Organizational Behavior and Human Performance 29 (1982):307-321; F. C. Miner, "Group vs. Individual Decision Making: An Investigation of Performance Measures, Decision Strategies, and Process Losses/Gains," Organizational Behavior and Human Performance 33 (1984):112-145.

(1977)[5] Furthermore, it provides support to concerns about excessive use of ad hoc groups that were voiced some 32 years ago by Lorge et al. (1958) that:

> A common and dangerous practice is to generalize the principles valid for ad hoc groups to traditioned [established, natural, or mature] groups. The ad hoc group is treated as a microscopic model of the traditioned groups. . . . It is . . . possible that ad hoc and traditioned groups behave in accordance with their individual principles.[6]

Group performance, as far as these data are concerned, improved significantly over time. If groups at lower level maturity could resemble ad hoc groups, expectations about future activities and relationships notwithstanding, then the excessive reliance on ad hoc groups may not be appropriate to develop a better and more complete understanding of basic ideas of real life groups.

As shown in Table 21, further investigation of the finding that there is no evidence for or against the existence of assembly effect bonus and of the influence of maturity shows: a) on the average, groups consistently scored higher than best member at every level of maturity; b) number of groups outperforming their best member significantly exceeds the number of groups that failed to outperform

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[5]J. Hall and M. Williams, "A Comparison of Decision-Making Performances in Established and Ad Hoc Groups," Journal of Personality and Social Psychology 3 (1966):214-222; D. L. Ford et al., "Group Decision-Making Performance as Influenced by Group Tradition," Small Group Behavior 8 (1977):223-228.

[6]I. Lorge et al., "A Survey of Studies Contrasting the Quality of Group Performance and Individual Performance," Psychological Bulletin 55 (1958):139-148.

TABLE 21

TEST OF HOMOGENEITY AMONG PROPORTIONS OF GROUPS OUTPERFORMING, EQUATING, AND BEING OUTPERFORMED BY THEIR BEST MEMBER

	Frequency (Percent)			
	Lower Maturity	Medium Maturity	Higher Maturity	Total
Group < Best Member	45 (20.45)	34 (15.45)	31 (14.09)	110 (16.67)
Group = Best Member	17 (7.73)	21 (9.55)	23 (10.45)	61 (9.25)
Group > Best Member	158 (71.82)	165 (75.00)	166 (75.45)	489 (74.09)
Total	220	220	220	660
Chi-Square	141.030	173.029	151.975	498.814
d.f.	2	2	2	2
Significance	p < 0.001	p < 0.001	p < 0.001	p < 0.001
Group Mean Score	174.823	181.203	184.061	
Best Member Mean Score	165.743	171.308	173.997	

their best member; and c) the finding in (b) above is consistent at each level of maturity. Therefore, groups seem to consistently outperform their best member, but not by a significant margin. This finding is supportive to a conclusion reached in the Lorge et al. review that:

> In general, in the evaluation of the relative quality of the products produced by groups in contrast to those products by individuals, the group is superior. The superiority of group, however, all too frequently, is not

as great as would be expected from an interactional theory.[7]

Research Question 2: Does group composition in terms of gender influence significantly the probability that groups will outperform their best member?

At the 0.05 level, with or without taking into account levels of maturity, there is no significant difference between group performance and best member performance that is due to gender composition of the group. At least as far as these data are concerned, gender composition does not seem to contribute to the existence of either assembly effect bonus or process loss. This particular influence, as far as I can gather, has not been empirically investigated before. Therefore, it is impossible to compare or contrast this finding to any other.

The influence of gender composition on group performance is significant at the 0.05 level. Generally, majority female groups and all-male groups significantly outperformed balanced groups. Tokenism does not seem to make the group better or worse than other groups. Also, the overall influence of gender seems to diminish over time ($p < 0.006$ at lower level of maturity, $p < 0.028$ at medium level of maturity, and $p < 0.362$ at higher level of maturity).

These findings seem to point to two directions: a) less mixed groups are more effective than mostly mixed ones; and b) as groups become more mature, the influence of

[7]Ibid., p. 369.

gender composition diminishes. The first point above runs contradictory, at least indirectly, to the findings by Hoffman et al. and Wood which showed mixed groups to be superior to one-sex groups[8] and to the findings by Hagood-Hastings indicating uniform (one-sex groups) and balanced groups are not significantly different from skewed (mostly male or mostly female) groups.[9]

The finding that all-male groups, mostly male groups, and mostly female groups are significantly different from each other could be taken as supportive to the direction of the findings by Bray et al. and Lamm et al. that all-male groups are not significantly different from all-female groups.[10]

To my knowledge, the finding above--that gender influence diminishes over time--has not been previously explored. This finding is not surprising, however. The basic differences between males and females, at least in

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[8]L. R. Hoffman et al., "Differences and Disagreement as Factors in Creative Group Problem Solving," Journal of Abnormal and Social Psychology 64 (1962):206-214; W. Wood, "Meta-analytic Review of Sex Differences in Group Performance," Psychological Bulletin 102 (1987):53-71.

[9]A. D. Hagood-Hastings, "The Effect of Gender Ratio on Individual Performance and Group Effectiveness in Problem-Solving Groups" (Ph.D. dissertation, Duke University, 1984), pp. 42-43, 74-75.

[10]H. Lamm and G. Trommsdorff, "Group Versus Individual Performance on Tasks Requiring Ideational Proficiency: A Review," European Journal of Social Psychology 3 (1973):361-388; R. M. Bray et al., "Effects of Group Size, Problem Difficulty, and Sex on Group Performance and Member Reaction," Journal of Personality and Social Psychology 36 (1978):1224-1240.

the context of this study, are due to interaction and communication styles. These differences are among those that are expected to be managed and resolved as groups become more mature.

The influence of group gender composition on the performance of best member is vague. There seems to be an overall effect ($p < 0.053$), but it could not be specified at the desired level of significance. This effect has not been previously investigated. Further exploration of this issue is probably needed before drawing any concrete conclusions, especially since the test power is only 0.42, hence raising concerns about the study's sensitivity in detecting already existing effect.

Research Question 3: Does group size influence significantly the probability that groups will outperform their best member?

At the 0.05 level, ANOVA failed, though barely ($p < 0.052$) to show a significant influence of group size on its ability to outperform its best member. Since desired level of significance in the ANOVA was not reached, specification of the influence was not determined. However, on the average, groups consistently outscored best member irrespective of group size. Furthermore, and only with the exception of groups with size 7, group performance and best member performance on the average diminishes as group size increases. These observations are shown in Table 22.

TABLE 22

AVERAGE PERFORMANCE BY GROUP SIZE

	Size			
	2, 3 & 4	5	6	7 & 8
Group	185.037	182.870	177.825	181.262
Best Member	172.629	172.230	169.520	170.217

Note: Maximum score possible = 200; minimum = 0.

Almost all studies in this area investigate group size influence on group performance but not on group performance relative to best member performance. The exceptions are J. D. Steiner's[11] contention that as group size increases, actual productivity decreases and process loss increases and subsequent empirical support by Bray et al.[12] Due to lack of significance in this study, support for these studies cannot be affirmed. However, the direction of the data, as imprecise and unreliable as that might be, seems to hint to Steiner's contention.[13] Furthermore, the test power of less than 0.40 weakens the results contradiction to these contentions.

In the investigation of group size influence on group performance, it is found that at 0.05 level there is

[11]Ivan D. Steiner, Group Process and Productivity (New York: Academic Press, 1972), pp. 67-83.

[12]R. M. Bray et al., "Effects of Group Size, Problem Difficulty, and Sex on Group Performance and Member Reaction."

[13]Ivan D. Steiner, Group Process and Productivity.

a significant influence of size on the group performance; groups of size 5 significantly outperformed those of size 6. Other groups are not significantly different from each other. When analyses were carried out at each level of maturity, it was found that size influence is significant only at medium level of maturity where groups of size 7 significantly outperformed those of size 6.

In light of the existing evidence, this particular finding is murky. The empirical evidence available provides three descriptions of the relationship between group size and group performance: a) there is no influence of size on group performance,[14] b) size is positively correlated with group productivity,[15] and c) size is negatively related to group performance.[16]

The general direction of this data is supportive of the negative relationship between size and group performance. However, the statistical evidence is more supportive to the lack of clear and concrete relationship between size and group performance. Among the sizes considered in

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[14]D. W. Taylor and W. L. Faust, "Twenty Questions: Efficiency in Problem Solving as a Function of Size of Group," Journal of Experimental Psychology 44 (1952):360366.

[15]E. J. Thomas and C. F. Fink, "Effects of Group Size," Psychological Bulletin 60 (1963):371-384; L. L. Cummings et al., "Effect of Size and Spacial Arrangement on Group Decision Making," Academy of Management Journal 17 (1974):460-475.

[16]Ivan D. Steiner, Group Process and Productivity; R. M. Bray et al., "Effects of Group Size, Problem Difficulty, and Sex on Group Performance and Member Reactions."

this study, only groups of size 5 significantly outperformed those of size 6.

At the 0.05 level, size does not have any significant effect on best member performance, irrespective of group level of maturity. At least as far as these data are concerned, best member performance appears to be independent of group size.

In summary, the conclusions were:

1. Over time, both group performance and best member performance improved significantly. However, while groups consistently outperformed their best member, the difference between group performance and best member performance was not significant.

2. Gender composition of the groups did not have any significant influence on group ability to outperform their best members. Gender composition, on the other hand, had a significant influence on group performance where all male groups and majority female groups significantly outperformed balanced groups. The influence on best member performance was not clearly identifiable.

3. The influence of size on the difference between group performance and best member performance is weak and unclear. Therefore, it was concluded that size was not a major determinant of group ability to outperform their best member. There was, however, a significant influence of size on group performance where groups of 5 significantly

outperformed groups of 6. Best member performance was independent of group size.

Recommendations for Future Research

Studies of individual versus group performance over time or longitudinally are scarce. The influence of maturity on individual versus group performance is not well established empirically. Replication of this present study should contribute to this aspect of small group research.

The task in this study is mini-multiple choice or true/false tests, 40% of which are recall items. Similar studies using tasks that are more complex, less defined, and involve more uncertainty are required. Tasks of this sort may resemble more the tasks in ongoing organizations. Also, other similar studies are required using different subjects. The subjects in this study are mostly students with high levels of education and who have exposure to, or training in, organizational behavior and group processes. What is valid for this population may not be necessarily valid for other populations. Groups, especially permanent groups in ongoing organizations, should be considered in future similar studies.

Group maturity is assumed in this study to improve over time and practice. There is a need to develop a more direct measure of group maturity. This measure should indicate, in some quantitative way, levels of group ability to resolve interpersonal problems and overcome obstacles to

valid communication and coordination and ability to achieve consensus. A measure of this sort should be a more useful indicator of maturity than just the time dimension of group life.

In the area of gender composition influence, I think there is a need for more studies that consider a variety of gender composition ratios. In general, The traditional all-male, all-female, and mixed categorizations may lead to insufficient understanding of the influence of gender composition. For example, in this study, in one case, majority-female groups significantly outperformed balanced groups; in another case, majority-female groups are not significantly different from majority-male groups, even though all of these groups are mixed. It seems to me that these examples hint to the possibility that group gender composition influence is related not only to one-sex or mixed-sex categorization, but rather to degree and direction of the gender mix. Therefore, considering a variety of gender composition ratios is probably a better strategy to understand gender composition role in individual versus group performance.

Furthermore, I think there is a need to go beyond the gender composition ratio to be able to draw clearer conclusions on and explanations of the findings. An investigation of the intra-group inter-gender processes of communication, conflict, priorities, etc. should enable the researcher to better interpret his/her findings.

In the area of size influence on individual versus group performance, there is a need for a study or studies similar to the present one in which one limitation in this study is avoided. In this study, groups with certain sizes (e.g., 2, 3, 4, and 8) are much fewer than others, which necessitated summing up groups with different sizes in one category. A study free of these limitations may lead to clearer conclusions about the influence of group size on individual versus group performance.

For research and practical implications, the heavy reliance on ad hoc groups may not be advisable. This study showed clearly that more mature groups significantly outperformed less mature groups. Therefore, it is recommended that in future research, established groups should be utilized more frequently. This recommendation is probably valid for those in the work place as well.

Finally, in group versus individual performance research, the concepts of assembly effect bonus and process loss are often, if not always, treated to be compatible and perfect opposites to each other. That mode of thinking is mostly a result of operationalization of these concepts, rather than a result of conceptual or theoretical considerations. I believe there is a need for seriously considering the differences between these two concepts, and in the process we hope to produce better conceptual and theoretical concepts to judge the differences between group and individual performance.

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