THE IMPACT OF TIME PRESSURE ON IDEA GENERATION: AN INVESTIGATION OF PRODUCTIVITY AND CREATIVITY UTILIZING COMPUTER SUPPORTED GROUPS

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A DISSERTATION

Submitted to
School of Business and Entrepreneurship
Nova Southeastern University

in partial fulfillment of the requirements
for the degree of

DOCTOR OF BUSINESS ADMINISTRATION

1997

UMI Number: 9735668

UMI
300 North Zeeb Road
Ann Arbor, MI 48103

A Dissertation
entitled

THE IMPACT OF TIME PRESSURE ON IDEA GENERATION: AN INVESTIGATION OF PRODUCTIVITY AND CREATIVITY UTILIZING COMPUTER SUPPORTED GROUPS

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We hereby certify that this Dissertation submitted by Robert M. Myers conforms to acceptable standards, and as such is fully adequate in scope and quality. It is therefore approved as the fulfillment of the Dissertation requirements for the degree of Doctor of Business Administration.

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions or writings of another.

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ABSTRACT

THE IMPACT OF TIME PRESSURE ON IDEA GENERATION: AN INVESTIGATION OF PRODUCTIVITY AND CREATIVITY UTILIZING COMPUTER SUPPORTED GROUPS

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The issues of time pressure and idea generation are vital concerns for businesses today. This dissertation examined the impact of time pressure on idea generation and creativity. One hundred and two business students were used to examine: (a) the mean rate of ideas generated, (b) the mean rate of generated hierarchical categories of ideas, (c) the mean rate of the creativity of generated ideas, and (d) the mean rate of idea chaining also noted as piggybacking.

This study utilized a computerized group support system to collect the data generated by the groups. Each group consisted of three, same-sex undergraduate business students. Each group performed three idea generating tasks utilizing three differing time periods. One time period was designed as high pressure, the second period provided adequate time to perform the task, and the third time period provided more time than necessary to perform the task.

Analyses of the data was conducted utilizing ANOVA, MANOVA, and independent raters. The data were examined to determine relationships between time pressure and variables associated with idea generation and creativity to further investigate Steiner's (1972) theory of productivity.

Results of the study supported the research hypotheses that the mean rate of: (a) idea generation, (b) creativity of ideas, (c) hierarchical idea categories, and (d) ideas chained is unequal in groups operating under differing time constraints.

ACKNOWLEDGMENTS

Completing this dissertation would not have been possible without the support of so many individuals. First, Cheri, thank you for your unending support and encouragement. Through your encouragement and that of Joshua and Roger, this dissertation became a reality.

To my dissertation committee, Dr. Jay Aronson, Dr. Robert Wharton, and Dr. Joe Eassa - a simple "thank you" seems inadequate. You have given of your time and talents. Your guidance and suggestions were greatly valued. I will always remember each of you and your remarkable gifts.

To my parents, Tom and Mary, your contributions to this process have been a special blessing. I have greatly treasured your continued encouragement.

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CHAPTER I

INTRODUCTION

This chapter provides an overview of the dissertation. The chapter: (a) provides a general discussion of research that has investigated the impact of time pressure on group productivity and creativity, (b) notes the links between Decision Support Systems (DSS), Group Decision Support Systems (GDSS or GSS), Electronic Meeting Systems (EMS), and Computer Supported Cooperative Work Systems (CSCW), (c) discusses the major tasks accomplished by a GDSS, (d) notes the major GDSS components that have been investigated and reported in GDSS literature, (e) provides the base theory that will be examined in this dissertation, (f) notes the background of the problem investigated in the dissertation as well as the purpose of the research, and (g) provides a definition of terms used throughout the dissertation.

Background of the Problem

In today's fast-paced business environment, time pressure is a reality of conducting business. Research, however, indicates that few studies have investigated this issue as it relates to group processes, productivity, and creativity (Kelly & McGrath, 1985). McGrath (1990) noted that research utilizing group support systems has seriously neglected time-related issues during prior investigations.

Some time pressure studies found that group decisions made under time pressure can lead to poor performance for government committees (Janis, 1982), businesses (Thurow, 1980), and juries (Greenberg, Williams, & O'Brien, 1986). Providing even too much time for group decisions can lead to boredom and dissatisfaction as identified by Karau and Kelly, (1992).

Steiner (1972) noted the importance of the process utilized by a group and that the process utilized impacts productivity. This dissertation focuses on this group process component of productivity as identified by Steiner (1972) utilizing brainstorming rules developed by Osborn (1957). Utilizing a GDSS, time pressure as it relates to group productivity and creativity will be investigated. The issues and research associated with time pressure as it relates to group creativity and productivity are examined as a separate component in the literature review.

Since brainstorming rules will be utilized in this research, it is vital to preliminarily discuss this issue. Osborn (1957) developed four rules that are essential to brainstorming theory. These include the following: (a) criticism of ideas is ruled out, (b) the wilder the idea the better, (c) the greater the number of ideas, the more the likelihood of winning ideas, and (d) the combination and improvement of ideas are desired. Osborn (1957) noted that not only must the four rules be followed, but group collaboration is a necessary element of the process. Osborn (1957) claimed that if his rules were followed, "the average person can think up twice as many ideas when working with a group than when working alone" (p. 229).

However, without the use of computer technology research has not supported Osborn's (1957) theory (Taylor, Berry, & Block, 1958; Diehl & Stroebe, 1987). Over twenty studies ranging from Taylor et al. (1958) to Diehl & Stroebe (1987) have found that nominal groups (individuals generating ideas on their own, which are then combined with the ideas of other individuals also working on their own) generate more ideas than the same number of people in face-to-face interacting groups (Gallupe, Bastianutti, & Cooper, 1991). Those investigating Osborn's (1957) theory encountered a variety of process losses resulting from group interactions (Steiner, 1972).

Osborn (1957) also noted the importance of "piggybacking" (idea chaining) on the ideas of others. Only recently have researchers begun to use computer technology to test this aspect of the theory (Dennis et al., 1995).

Through the use of group support systems it is possible to contribute to the investigation of the processes of group productivity and creativity. This dissertation will combine today's available GSS technology with current research to further investigate time pressure and its impact on group productivity and creativity (Steiner, 1966, 1972; Kelly & Karau, 1993).

Discussion of Key Prior Research

The study of worker productivity has been a reoccurring theme in management literature. Taylor (1916) noted the importance of productivity and its relationship with time when the principles of scientific management were developed. Fayol (1916) also noted methods of increasing productivity and subsequently developed principles of management that have been carried forward.

Productivity issues later spawned a variety of research that examined methods to motivate workers to achieve higher productivity rates. Maslow (1943) developed the needs hierarchy theory as an attempt to explain motivation. Herzberg (1968) developed the dual-factor theory as a method of explaining the motivational process. McGregor (1957) examined motivation from the manager's perspective with the development of Theory X and Y. Many of the classic management studies have focused on this issue of productivity and related issues (Taylor, 1916; Fayol, 1916; Herzberg, 1968).

Taylor (1916) also noted the importance of utilizing the "proper" tools, to enhance productivity. One set of tools that have been utilized to explore both productivity and creativity issues in meetings is group support systems (GSS). The use of a GSS to enhance group productivity has been, and continues to be, an important research topic.

Group support systems attempt to improve process gains while reducing process losses as identified by Steiner (1966, 1972). A GSS has been defined as "an integrated combination of specialized hardware, software, and procedures to support group activity" (Zigurs & Kozar, 1994, p. 278).

Throughout the literature a GSS has been referred to under a variety of names. It has been referred to as a Group Decision Support System (GDSS) or a Group Support System (GSS). For purposes of this dissertation, a GDSS and GSS are synonymous. As such, a GSS refers to a combination of computer, communication, and decision technologies to support problem formulation and problem solving in a group setting (DeSanctis & Gallupe, 1987; Aronson, Aronofsky, & Gray, 1987). GSSs are different from Decision Support Systems (DSSs) from which they were developed. This difference is that GSSs concentrate on the group not the individual. Additionally, since GSSs are concerned primarily with short-term problem solving, they are distinguished further from the general category of computer supported cooperative work (CSCW) systems (Connolly, Jessup, & Valacich, 1990).

Dennis, George, Jessup, Nunamaker, & Vogel (1988) developed their version of the GSS which was called the electronic meeting system (EMS). EMS moved beyond the decision making function which was implied in the term "group decision support system." An EMS could also provide a foundation for idea generation, planning, and creativity (Dennis et al., 1988). This dissertation is conducted using the definition supplied by Kraemer & King (1988). They noted that a GSS refers generally to computer-based efforts to make group meetings more productive.

With this broad definition, a GSS can assist in many phases of group activities. DeSanctis & Gallupe (1987) noted that a GSS can be used for a variety of tasks, however, these tasks can be classified as serving three main purposes. These purposes are: (a) to generate ideas, (b) to choose an appropriate option, and/or (c) to negotiate. As a result of the variety of tasks that can be performed using a GSS, a variety of researchers have investigated various aspects of group interaction and the ability of a GSS to impact the process.

Researchers have also examined the anonymity component of GSS (Collaros & Anderson, 1969; Connolly, Jessup, & Valacich, 1990). Here researchers attempted to determine if keeping meeting participants anonymous contributed positively or negatively to the overall group process. Researchers have examined the multiple dialogs component associated with GSS (Dennis et al., 1995). Investigation in this area examined the impact of group participants contributing multiple ideas simultaneously rather than singularly as in traditional face-to-face meetings.

Group size is another GSS component that has been investigated (Dennis & Valacich, 1994; Hill, 1982). Researchers in these studies investigated the proper size for optimum group performance.

Other major GSS components investigated in additional studies include: (a) user attitudes toward GSS (Ginzberg, 1981; Davis, Bagozzi, & Warchaw, 1989; Zigurs, DeSanctis, & Billingsley, 1991), (b) user satisfaction regarding the GSS process (Sambamurthy & Chin, 1994), (c) productivity loss in the GSS environment (Diehl & Stroebe, 1987; Steiner, 1972), (d) group creativity (Glover & Chambers, 1978; Hare, 1982; Kelly & Karau, 1993; Nunamaker, Applegate, & Konsynski, 1987), (e) conflict management in computer-supported meetings (Poole, Holmes, & DeSanctis, 1991; Miranda & Bostrom, 1994), (f) the role of the group facilitator (Clawson, Bostrom, & Anson, 1993), (g) the proper design of a GSS (Huber, 1984), (h) the performance of individuals versus groups (Hill, 1982; Hackman & Kaplan, 1974; Bourgeois, Horowitz, & Lee, 1995; Lamm & Trommsdorff, 1973), and (i) the impact of GSS on long-range planning (Jessup & Kukalis, 1990).

The elements of group processes and their association with GSS continues to be investigated in the literature (Osborn, 1957; Lamm & Trommsdorff, 1973; Jablin & Seibold, 1978; Maginn & Harris, 1980; Diehl & Stroebe, 1987; Connolly, Routhieaux, & Schneider, 1993; Gallupe & Cooper, 1993). Group processes and their associated gains and losses have supplied the opportunity for researchers to examine a variety of group interaction variables and their association with GSS. This dissertation will utilize a GSS to investigate the impact of time pressure on group productivity and creativity.

This research area investigating the impact of time pressure on the processes of group productivity and creativity is gaining attention in the literature (Kelly & McGrath, 1985; Kelly, Futoran, & McGrath, 1990; Kelly & Karau, 1993). This dissertation focuses on this time pressure component of group processes. To date, research indicates that a GSS has never been utilized to investigate the impact of time pressure on group productivity and creativity. Computer technology now makes the use of a GSS possible to further investigate this area of research.

Purpose of the Research

The theory upon which this research is based is Steiner's (1972) productivity theory. Steiner (1972) noted that the productivity of a group depends upon three "classes of variables" (p. 6). These variables include task demands, resources, and processes.

Steiner's (1972) productivity theory noted that group productivity could be defined as follows (p. 9):

Actual productivity = potential productivity - losses due to a faulty process

Steiner (1972) defines actual productivity as that which the individual or group accomplishes when given a task to complete. Potential productivity, however, was defined as the maximum level of productivity that occurs when a group or individual makes the best use of its resources to accomplish a task. Steiner (1972) noted that actual productivity rarely equals potential productivity since losses in productivity generally occur from a faulty process during task completion.

Current research has noted that time constraints in the group process impacts the productivity and creativity of groups (Kelly et al., 1990; Kelly & Karau, 1993) It is this time constraint component, or faulty process, that will be investigated in this research. By investigating the time pressure component of group processes, Steiner's (1972) theory can be further studied. As a component of the research, a GSS will be utilized to collect the data from the participants of this study.

The consequences of a faulty group process as noted by Steiner (1972) are a reoccurring theme in academic literature and frequently noted in group decision making theories (Osborn, 1957; Lamm & Trommsdorff, 1973; Shaw, 1981). Therefore, further research regarding faulty processes and their impact on productivity is warranted.

Statement of the Problem

Much research has investigated the impact of the processes used during group interaction. However, there has been very little research that investigated the impact of time pressure on idea generation within a group setting as noted by McGrath (1990).

As noted previously, Steiner's (1972) productivity theory was built upon the premise that the processes utilized to solve tasks will impact productivity. Although Steiner (1972) stated this productivity theory in a very broad manner, researchers continue to investigate various components of potential faulty group processes (Lamm & Trommsdorff, 1973; Shaw, 1981; Kelly, Futoran, & McGrath, 1990; Kelly & Karau, 1993; Dennis et al., 1995). This dissertation will contribute to the current body of knowledge by investigating time pressure, an aspect of group process that is just beginning to be examined by researchers (Kelly & Karau, 1993).

The basic research question to be investigated is the following: : does the addition of time pressure into group processes impact group productivity, idea creativity, and idea chaining?

Definition of Terms

For the purposes of this study, the following terms and their associated definitions are used:

Actual Productivity: What the individual or groups actually accomplish when asked to complete a task.

Brainstorming: A method used to generate ideas that utilizes the following rules: (a) criticism of ideas is ruled out, (b) the wilder the idea the better, (c) the greater the number of ideas the more the likelihood of winning ideas, and (d) the combination and improvement of ideas are desired.

Computer Network: A network of personal computers within a confined geographical area that is comprised of servers, workstations, a network operating system and a communications link.

Servers are high-speed machines that hold programs and data shared by all network users. A workstation is a user's machine, which can also function as a stand-alone personal computer.

The physical transfer of data is performed by the access method, such as Ethernet or Token Ring, which come in the form of network adapters that plug into each computer. The actual link, or communications path, is the cable that plugs into each network adapter and connects workstations and servers.

Chaining of Ideas: The combination and improvement of ideas. Also referred to as "piggy-backing."

Creativity: For the purposes of this study creativity is defined by multiple raters utilizing both a creativity scale and hierarchical categorization.

Decision Support Room: The physical space in which the GSS research participants complete their tasks. This area also physically houses the GSS hardware.

Decision Support Systems (DSS): Similar to a GDSS but focus on individual rather than group activities.

Electronic Meeting Systems (EMS): An EMS moves beyond the decision making function which was implied in the term "group decision support system." An EMS also provides a foundation for idea generation, planning, and creativity.

Facilitator: An individual who reads the research scripts to participants and assures that the research instructions are followed.

Group Support Systems (GSS): A combination of computer, communication, and decision technologies to support problem formulation and problem solving in a group setting. The term "Group Decision Support System" (GDSS) may be used interchangeably with GSS.

Potential Productivity: The maximum level of productivity that can occur when an individual or group makes full use of its resources to accomplish a task.

Processes: This is defined by either: (a) process gain or (b) process loss. For the purposes of this study process gains are synergistic occurrences resulting from group interaction while process losses are negative consequences of group interaction.

Rate of Idea Generation: The number of ideas generated during a specific time period. For purposes of this study the rate of idea generation is defined as the total number of ideas generated per 30 second interval.

Script: Written instructions that are read to research participants to disseminate instructions and assure consistency in instruction among participants.

CHAPTER II

A REVIEW OF THE LITERATURE

This chapter focuses on specific aspects of time pressure studies and GSS research as well as specific group processes identified in the literature. The literature review uses a chronological approach to GSS research beginning in the 1950s and progressing to the 1990s. Throughout these years, significant developments relating to GSS are noted and discussed. Additionally, GSS is linked with various theories that contributed to its development such as: (a) brainstorming theory, (b) communications theory, and (c) human information processing theory. A variety of models are used to depict the links between these theories and GSS.

Chapter II also discusses relevant literature that examines how time pressure impacts group processes. The current findings regarding time pressure and its impact on group productivity and creativity are noted and discussed.

Theory Bases for Previous GSS Research

The methods used by groups to make decisions is a recurring theme in business literature. With improvements in computer technology, the practice of generating ideas in face-to-face meetings could become a thing of the past. Many of the idea generation process losses that are common in face-to-face meetings are removed with the use of technology. Technology, and its application to group support systems (GSS), allows participants to generate ideas anonymously, note ideas whenever they occur, and "piggy back" on the ideas of others. No longer must potential contributors remain silent for fear of the penalties associated with disagreeing with the ideas of their manager. Today's GSS allow relatively large numbers of participants to generate ideas electronically while all the other meeting participants are doing the same.

Group support systems have been defined as "an integrated combination of specialized hardware, software, and procedures to support group activity" (Zigurs & Kozar, 1994). Today, a GSS often consists of about 20 networked personal computers. The computers are often placed in a U-shape with a facilitator in the center of the room. Within view of all participants is a large viewing screen that allows all the participants the opportunity to observe all ideas generated by the group. Additionally, each computer screen allows the individual user to view both their ideas as well as the ideas generated by the group. A GSS room design example can be found in Figure 14.

Much of the early research in the GSS area concentrated on one central theme. This central theme was to determine if the benefits of a technology driven idea generation system were superior, in terms of both quality and quantity, to face-to-face traditional approaches. There have been conflicting findings in the literature. Current research continues to study this area as well as concentrating on specific aspects of group support systems. Some of the specific areas being investigated include: (a) the appropriate group size for GSS use, (b) the roles of participants in GSS meetings, (c) the impact on anonymity on group decision making, (d) the rate of idea generation in electronic groups versus nonelectronic groups, and (e) idea chaining within groups. There are a variety of additional GSS investigations which are discussed in this literature review.

The theory bases for the study of GSS come from three distinct theories. These theories are group dynamics (Osborn, 1957), communication theory (Shannon & Weaver, 1949) and human information processing theory (Norman, 1976). However, the specific base theory for the study of GSS is grounded in group dynamics theory.

The work of Osborn (1957) is a foundation for much of the research that has been conducted in the area of idea generation. Osborn (1957) developed four rules that are essential to brainstorming theory. These included the following: (a) criticism of ideas is ruled out, (b) the wilder the idea the better, (c) the greater the number of ideas the more the likelihood of winning ideas, and (d) the combination and improvement of ideas are desired. Osborn (1957) noted that not only must the four rules be followed, but group collaboration is a necessary element of the process. Osborn (1957) claimed that if his rules were followed, "the average person can think up twice as many ideas when working with a group than when working alone" (p. 229). This claim, however, has not been consistently supported in the literature (Taylor et al., 1958; Diehl & Stroebe, 1987).

In related research, Steiner (1966) noted that each group member possessed abilities unshared by other members. By combining these abilities, groups could surpass the performance of people working independently. Steiner (1972) further noted that actual productivity could be defined as potential productivity minus losses due to a faulty process. These process losses and gains are a recurring theme in business literature and are frequently noted in group decision making theory (Steiner 1966, 1972; Lamm &

Trommsdorff, 1973; Shaw, 1981; Hill, 1982; Diehl & Stroebe, 1987).

Through GSS it is possible to test Steiner's (1972) productivity theory. Specifically, this dissertation investigates the impact of time pressure on the rate of ideas, idea creativity, and idea chaining utilizing a GSS. The interjection of time constraints is useful for testing Steiner's (1972) theory that the group process used during task completion impacts group productivity.

Historical Background of GSS: 1950-1979

The Concept of Brainstorming

Many organizations have a desire to improve the methods used in group decision making activities. As a result, much research has taken place to identify methods that would produce more efficient and effective group decision making. Much of the early research did not involve the use of technology but made use of other techniques often centering around the concept of brainstorming. This brainstorming theory was supplied by Osborn (1957) as a method of group problem solving to increase the quality and quantity of ideas developed by group members. Taylor et al. (1958) were some of the first to test Osborn's theory. Taylor et al. (1958) found that nominal groups produced nearly twice as many different ideas as the larger groups. The definition of nominal groups used by Gallupe, Bastianutti, & Cooper (1991) will be used throughout this dissertation. Gallupe et al. (1991) defined nominal groups as "individuals generating ideas on their own, which are then combined with the ideas of other individuals also working on their own" (p. 137).

Years later, Diehl & Stroebe (1987) discussed 22 brainstorming experiments conducted by a variety of researchers. They found that of the 22, 18 reported the performance of nominal groups to be better than the interacting groups in terms of quantity of ideas (Diehl & Strobe, 1987). However, Diehl & Stroebe (1987) reported that the findings were not as consistent when measuring these ideas in terms of quality.

Bouchard & Hare (1970) also investigated the concept of brainstorming in some of their early studies. Bouchard & Hare (1970) compared brainstorming groups of five, seven, and nine members with nominal groups composed of individuals who brainstormed alone. This study used 168 male students from an introductory psychology class who were required to participate in the experiment as a class requirement. Participants were asked to work on the "thumbs problem" which required them to determine benefits and difficulties associated with placing an extra thumb on the outer side of each hand (Bouchard & Hare, 1970).

Specific instructions were given to the participants in this study. Participant's were asked to follow Osborn's (1957) brainstorming rules (Bouchard & Hare, 1970). Tape recorders and closed circuit television were used to monitor the participants.

Bouchard & Hare (1970) compared the performance of five-, seven-, and nine-person brainstorming groups with nominal groups composed of individuals brainstorming alone. Bouchard & Hare (1970) examined the total number of nonoverlapping ideas produced in each of the conditions.

This study found that the larger groups produced more ideas, however, the nominal groups were more effective than the larger brainstorming groups. This study found that some participants in the larger groups monopolized much of the time without producing any benefit. These individuals would elaborate in ways that did not directly contribute to solving the problem (Bouchard & Hare, 1970).

Bouchard & Hare (1970) found that using group brainstorming over a variety of group sizes, inhibits creative thinking. Pooled individual effort is more productive than group effort. Their work would later be followed by many who studied the impact of group size on brainstorming in the GSS environment (Gallupe et al., 1992; Dennis & Valacich, 1994).

Lamm & Trommsdorff (1973) noted that one of the major problems associated with real groups was that only one member could speak at a time. Diehl & Stroebe (1987) called this condition production blocking. Group members who are prohibited from voicing their ideas when they occur may simply forget them or choose not to mention them because they appear less relevant as time goes on (Diehl & Stroebe, 1987).

Collaros & Anderson (1969) approached their early investigations of brainstorming from a different perspective. Their study manipulated the perceived expertise of group members in brainstorming groups. Collaros & Anderson (1969) assumed that group members would say less if they believed that other members of their group were experts in the field of the problem setting.

These researchers found that productivity was highest in the group that did not believe any experts were part of their group. This confirmed the original hypothesis of the study (Collaros & Anderson, 1969). Additionally, participants in the groups that were supposed to contain experts, noted that they were less likely to voice ideas due to feelings of inhibition (Collaros & Anderson, 1969).

Years later, a study conducted by Maginn and Harris (1980) had different results. In this study, some brainstorming groups were told that there were three judges on the other side of a "one-way mirror" who would rate the group member's ideas for "quality and quantity" (Maginn & Harris, 1980, p. 221). The findings showed that individual productivity in the groups who believed they were being watched was not significantly different from the individuals in groups who were not told they were being watched (Maginn & Harris, 1980).

Group Process Gains and Losses

There are a variety of group process gains and losses that have been identified in the literature. Since GSS attempts to impact these process gains and losses, it is important to note these prior to discussing GSS development in the 1980s and 1990s. Many of these process gains and losses were compiled by Nunamaker, Dennis, Valacich, Vogel, and George (1991b).

Process Gains

1. Additional Information: The group has more information than a single member (Lamm & Trommsdorff, 1973; Shaw, 1981; Steiner, 1966).

2. Learning: Group members may learn from more skilled group members (Hill, 1982).

3. Stimulation: Working with others may stimulate creativity (Lamm & Trommsdorff, 1973; Shaw, 1981).

4. Synergy: The process of group members using information differently than first intended due to the diversity of knowledge within the group (Osborn, 1957; Nagasundaram & Dennis, 1993; Gallupe et al., 1992).

5. Thorough Evaluation: Groups can detect errors more effectively than individual members (Hackman & Kaplan, 1974; Hill, 1982; Shaw, 1981).

Process Losses

1. Air Time Fragmentation: The available speaking time must be divided among members (Diehl & Stroebe, 1987; Jablin & Seibold, 1978; Lamm & Trommsdorff, 1973).

2. Attention Blocking: Group members must constantly listen to others and cannot stop and think (Diehl & Stroebe, 1987; Jablin & Seibold, 1978; Lamm & Trommsdorff, 1973).

3. Attenuation Blocking: Group members who are forced to wait, forget or suppress their ideas when they occur (Diehl & Stroebe, 1987; Jablin & Seibold, 1978; Lamm & Trommsdorff, 1973).

4. Cognitive Inertia: Discussion is centered around one thought because group members do not contribute ideas that

are not directly related to the topic at hand (Jablin & Seibold, 1978; Lamm & Trommsdorff, 1973).

5. Concentration Blocking: Comments are not made by group members because they are concentrating on remembering their own comments (Diehl & Stroebe, 1987; Jablin & Seibold, 1978; Lamm & Trommsdorff, 1973).

6. Conformance Pressure: Group members are hesitant to criticize comments of others due to politeness or fear of retaliation (Hackman & Kaplan, 1974; Shaw, 1981).

7. Coordination Problems: Integration of member contributions is difficult because there is no group strategy (Hackman & Kaplan, 1974; Hirokawa & Pace, 1983).

8. Domination: Group members monopolize the group's time in an unproductive manner (Jablin & Seibold, 1978).

9. Evaluation Apprehension: Members withhold ideas because of the fear of negative evaluation (Diehl & Stroebe, 1987; Jablin & Seibold, 1978; Lamm & Trommsdorff, 1973).

10. Failure to Remember: Members forget the contributions of others (Diehl & Stroebe, 1987; Jablin & Seibold, 1978).

11. Free Riding: Members rely on others to contribute ideas (Albanese & Van Fleet, 1985; Diehl & Stroebe, 1987).

12. Incomplete Task Analysis: Group members do not properly analyze and understand the task (Hirokawa & Pace, 1983).

13. Incomplete Use of Information: Members are unable to access the necessary information to successfully complete the task (Hirokawa & Pace, 1983; Mintzberg, Raisinghani, & Theoret, 1976).

14. Information Overload: Information is obtained faster than it can be processed (Newell & Simon, 1972; Hiltz & Turoff, 1985).

15. Socializing: Task performance is reduced through social (non-task) activities (Shaw, 1981).

It is vital to understand these process gains and losses, since during the 1980s, technology was introduced into the group decision making process. Research shows that technology can contribute to both process gains and losses (Hiltz & Turoff, 1985; Diehl & Stroebe, 1987; Lamm & Trommsdorff, 1973; Shaw, 1981). The contribution made by the GSS is to enhance process gains while reducing process losses.

The GSS Environment in the 1980s

GSS and Brainstorming Concepts

Steeb and Johnston (1981) proposed the use of technology to assist with group decision making that utilized the concepts of brainstorming. This research involved the use of a minicomputer to assist in the decision making process.

Several groups of graduate students were paid to participate in a simulation designed to produce a decision within a three hour time limit. The students were divided into unaided and aided groups. The aided groups used the computer and associated software package (group decision aiding system) to assist with the decision (Steeb & Johnston, 1981).

The group decision aiding system was designed to assist group decision making in five areas which included the following: (a) decision tree structuring, (b) full group participation, (c) identification of critical issues, (d) conflict resolution, and (e) decision recommendation (Steeb & Johnston, 1981). The results of this study showed some significant findings relative to technology assisted group decision making.

The technology aided groups in this study considered 65 percent more attributes in their deliberations and generated 60 percent more potential actions and events compared with the unaided groups (Steeb & Johnston, 1981). The aided groups also showed superiority regarding the comprehensiveness of the information considered as well as the completeness and appropriateness of the alternatives generated (Steeb & Johnston, 1981).

The time used to arrive at a decision also differed significantly between the aided and unaided groups. The aided groups continued almost to the deadline, averaging 2 hours and 48 minutes. The unaided groups averaged 2 hours and 28 minutes. Additionally, 77 percent of the aided members fully supported the group's decision. Only 53 percent of the unaided group's members fully supported the group's decision (Steeb & Johnston, 1981).

Steeb and Johnson (1981) note that the technology utilized in their study aids the managerial decision process in the following five categories:

1. Decision Tree Structuring: The decision tree is a means of quickly examining previous developments and to compare the decision choices made.

2. Full Group Participation: Each group member is able to equally participate in the decision process. Additionally, domination by any of the participants is minimized.

3. Identification of Critical Issues: The decision tree approach identifies those parts of the decision tree most critical to the final decision and allows participants to concentrate in these areas.

4. Conflict Resolution: A technology aided system helps identify conflicts and provides a procedure for solving the conflict.

5. Decision Recommendation: A technology aided system can recommend a course of action based upon the inputs of all the group members.

During the late 1980s the advent of fast-paced technological change caused a great interest in combining this technology with group decision making. It has been noted that managers spend a large amount of time in meetings (Mintzberg, 1973). The meeting process itself is comprised of a variety of information exchange patterns that take place as the participants strive to reach a decision (DeSanctis & Gallupe, 1987).

The pattern of interactions of decision makers changes throughout a meeting. Participants interpret comments differently, use different decision rules, and rely on power in different ways at various points in a meeting (Poole, Seibold, & McPhee, 1985). The one consistent pattern was that groups tended to either solve the task at hand or focus on the group's social needs (Blake & Mouton, 1964). This has some important impacts concerning the design of a group support system (GSS).

DeSanctis and Gallupe (1987) noted several of these concerns. First, a GSS must allow for a wide range of decision processes within groups. Groups simply use different processes at different times to reach a decision.

Second, many groups will benefit from tools that allow them to plan the meeting. These may simply be tools that allow group members to set the agenda or allow for a structured problem formulation within the groups. Third, the GSS must attempt to support both task and social needs within the group. DeSanctis and Gallupe (1987) provide a framework for establishing such a GSS.

Examining GSS from a different perspective, Liang (1988) argued that many GSS simply serve as a method for exchanging information and ideas. Liang (1988) referred to some GSS as "communication blackboards" (Liang, 1988, p. 667). Liang (1988) argued that this may suit some group processes, however, there are times when more complex support is indicated.

Liang (1988) noted that there are occasions when a decision is not agreed upon due to differences in the models being applied by the group members. As a result, conflict can quickly develop within the group. Liang (1988) proposed a model management system (MMS) that would work as part of the GSS to provide consistency among decision makers.

Also examining the "communication blackboard" concept were Jarvenpaa, Srinivasan Rao, and Huber (1988). They investigated whether groupware in face-to-face meetings is functionally advantageous. Jarvenpaa et al. (1988) noted that a review of the literature revealed five common limitations in the research that had been conducted on GSS. Those limitations included the following: (a) prior research used small groups, (b) previous studies were single-meeting experiments, (c) experimental tasks were poorly matched with the computer technology, and (d) prior studies examined "decision rooms" as a whole rather than the components (Jarvenpaa et al., 1988).

The results of the study noted a variety of statistical findings, however, one interesting note was that the users of the technology did not fully understand its capabilities. Although Jarvenpaa et al. (1988) noted that some of the technology was ineffective, it was noted that the study also revealed a lack of user training.

The design of the EMS environment must facilitate the processes that will be used (Dennis et al., 1988). For example, anonymity has been shown to impact the outcome of meetings (Connolly, Jessup, & Valacich, 1990). If anonymity were part of the process, the environment must be built to support that part of the process.

One of the findings noted by Dennis et al. (1988) is that there is a lack of standardization across studies to develop a variety of broad generalizations regarding GSS. One thing is certain and that is an EMS must use the "toolkit" approach if it will be used in future meetings that transcend time and space (Dennis et al., 1988).

Watson, DeSanctis, and Poole (1988) examined GSS from another perspective. Their study took the approach that there were situations where there was no objective measurement of decision quality. Often, groups must reconcile differences of opinion, personal preferences, and judgment to finally achieve agreement regarding a decision (Watson et al., 1988). Watson et al. (1988) also investigated both intended and unintended consequences of a GSS.

Forty-four three-person and 38 four-person groups participated in this study. The teams were required to allocate a limited number of funds to six competing projects (Watson et al., 1988). The study noted several interesting findings. First, a GSS actually facilitated conflict management in groups. Second, the study noted the importance of a facilitator. On occasion, group members would type questions such as "Who said that?" in response to member comments (Watson et al., 1988, p. 475). Third, some group members expected the computer to give the correct answer. Rather than work on the problem, the users concentrated on the technology (Watson et al., 1988). Additionally, the users in the GSS groups felt that they had provided more input to the group's solution than group members who did not use the GSS.

Gallupe and DeSanctis (1988) noted that much of the GSS research involves groups solving some "crisis management" task (Gallupe & DeSanctis, 1988, p. 277). Gallupe and DeSanctis (1988) propose examining group decision quality based upon a problem-solving approach rather than the crisis management task. Participants were made aware of the symptoms but had to determine the problems.

Gallupe and DeSanctis (1988) measured decision quality using two dimensions: (a) decision content and (b) decision reasoning. Decision content was defined by how close the group's decision was to that of the experts. Decision reasoning was defined as the degree of similarity between the group's reasoning and the expert's reasoning (Gallupe & DeSanctis, 1988). This is very similar to the approach used by Steeb and Johnston (1981).

The findings of this study showed that a GSS improved decision quality for both higher and lower difficulty tasks (Gallupe & DeSanctis, 1988). Second, using a GSS placed an agenda on the group that assisted in the structure of the process. Third, the GSS acted as a "group memory" that allowed the group to better analyze information (Gallupe & DeSanctis, 1988, p. 239).

This "group memory" allowed members to consider more alternatives in a more thorough manner than the groups that did not use a GSS (Gallupe & DeSanctis, 1988). This finding was consistent with the finding of Steeb and Johnston (1981) regarding the increased number of alternatives generated by a GSS.

User Acceptance of GSS (1980s)

As the investigation of GSS continued in the late 1980s, it became evident that the technology could not be effective if it was not used. It had long been known that user acceptance of technology remained an important and challenging issue (Swanson, 1987). Davis, Bagozzi, and Warshaw (1989) completed a study that examined the use of technology. This study involved the use of MBA students to try and determine or predict how technology would be used.

The findings of this study showed the following: (a) people's computer use could be predicted reasonably well from their intentions, (b) perceived usefulness was a major determinant of people's intentions to use computers, and (c) perceived ease of use was a significant secondary determinant of people's intentions to use computers (Davis et al., 1989).

Ginzberg (1981) identified some techniques for predicting potential user acceptance problems. This study also noted that the most cost effective method for dealing with user acceptance issues was to identify the problem as early in the development process as possible. The problem, however, was how to realistically describe the completed system to the users so early in the development process (Davis et al., 1989). Davis et al. (1989) also noted that users may be willing to accept difficult system interfaces if they perceived the system was useful.

The GSS Environment in the 1990s

The consideration of environment was also noted by Nunamaker, Dennis, Valacich, and Vogel (1991a). Their approach to the proper GSS environment included the concept of a GSS "toolkit" approach (Nunamaker et al., 1991a, p. 1342). In this approach, each tool would be designed to support an aspect of the total process. With this approach, technology that best fit the task would be used (Nunamaker et al., 1991a).

The EMS environment was an important consideration for EMS group experiments (Dennis, Nunamaker, & Vogel, 1991). This study noted that the use of chauffeured, supported, or interactive processes may have different effects on the outcome of the meeting. With the variety of processes used in EMS experiments, it was difficult to compare research results across experiments (Dennis et al., 1991).

Nunamaker et al. (1991b) again made the recommendation for the EMS to be a toolkit that may be used by groups working on different processes. This study noted that EMS may provide benefits to groups based upon the following: (a) parallel communications keep any single member from dominating the meeting, (b) anonymity allows issues to be discussed more openly, (c) group memory allows a permanent record of the meeting to be kept, (d) the EMS serves as a structure to focus the group, and (e) task support allows members to better analyze information (Nunamaker et al., 1991b).

Consistent with other GSS research, Nunamaker et al. (1991b) noted that the results of EMS research cannot be applied to all group settings. This study noted that only by defining the scope of the study and interpreting the results could the study have meaning (Nunamaker et al., 1991b).

Dennis, Nunamaker, and Vogel (1991) examined the differences between laboratory and field research. Dennis et al. (1991) cautioned researchers against generalizing their findings to all groups. With that in mind, it is important to examine the components of the research process involving EMS. It is equally important to properly build the groups that will participate in any EMS experiment.

The practice of using students as participants is often done out of necessity. Dennis et al. (1991) noted that if students are used, it was far better to use more mature students (graduate students) to less mature (undergraduate students). Care should also be taken when deciding whether to study similar or diverse groups (Dennis et al., 1991).

GSS and Real-World Problems

Post (1993) took GSS research to the field utilizing a major American corporation. Post (1993) used 654 people in the group sessions. The mean group size was 10.2. The average session time was 4.7 hours. Some of the findings are noteworthy. Using GSS, the company saved $432,260 labor dollars, $6,754 mean labor dollars per GSS session, 11,678 total labor hours, and 1,773 total person days of flowtime (Post, 1993). In a post session questionnaire, group members also noted their satisfaction with the GSS process (Post, 1993).

Sheetz, Tegarden, Kozar, and Zigurs (1994) utilized a GSS to develop a cognitive map of users of object-oriented programming techniques to examine their perceptions of system complexity. Using a GSS, seven participants identified concepts and categories associated with object-oriented programming, categorized the concepts, rated category importance, and defined relationships between categories (Sheetz et al., 1994).

The findings of this study showed that it was possible to use a GSS to build cognitive maps. Based upon this approach, Sheetz et al. (1994) noted that a GSS may actually be used to develop survey instruments due to the efficiency built into the GSS process (Sheetz et al., 1994).

Alavi (1994) took the GSS into the classroom for use in case analysis. This study, which involved MBA students, found that those who used the GSS in their classwork perceived higher levels of "skill development, learning, and interest in learning" compared with the students who were not exposed to the GSS (Alavi, 1994, p. 170). Additionally, those students who used the GSS had greater satisfaction with the classroom and group learning activities as compared with those students who were not exposed to the GSS (Alavi, 1994).

GSS and Brainstorming Concepts

Gallupe and Cooper (1993) noted both advantages and disadvantages of electronic brainstorming as a subset of GSS. Their study noted the following advantages of electronic brainstorming: (a) parallel entry of ideas, (b) anonymity, (c) increased quantity of ideas generated, (d) increased member satisfaction, (e) allowed large groups to be effective, (f) provided a record of ideas for future reference, (g) allowed information to easily be edited and evaluated (Gallupe & Cooper, 1993).

Gallupe and Cooper (1993) also noted disadvantages of electronic brainstorming, which included: (a) oversold as a cure-all, (b) required some keyboarding skill, (c) loss of position power for senior managers, (d) loss of social interaction, and (e) cost of technology (Gallupe & Cooper, 1993).

GSS and Long Range Planning

During 1990, the use of GSS was investigated by Jessup and Kukalis (1990) as an aid in long range planning. Jessup and Kukalis (1990) noted some of the common problems associated with long range planning. These included the following: (a) lack of an appropriate planning environment, (b) lack of understanding regarding the planning process, (c) key individuals were not a part of the planning process, and (d) failure of top management to communicate the new plans to others within the organization (Jessup & Kukalis, 1990).

Jessup and Kukalis (1990) noted some of the same results as mentioned by McGoff, Hunt, Vogel, and Nunamaker (1990) regarding the GSS experiences at IBM. Jessup and Kukalis (1990) noted both technological efficiencies and interaction advantages that accompanied the use of a GSS for long range planning. Technological efficiencies of a GSS included: (a) providing structure to the process, (b) parallel processing of ideas, (c) a written record of the actual planning process, and (d) easy access to external information. Interaction advantages of GSS use included: (a) a convenient forum for planning, and (b) anonymous interaction among participants (Jessup & Kukalis, 1990).

GSS and Anonymity

McGoff et al. (1990) explored the use of GSS at 22 IBM Corporation sites. This study reported that the GSS was continually used by a variety of corporations. GSS facility coordinators reported 3 to 4 week backlogs for use of the GSS facilities were not unusual. Additionally, high-level managers who had used the GSS facilities had "publicly championed" their use (McGoff et al., 1990, p. 51). This study also reported the benefits of anonymity as part of the process (McGoff et al., 1990).

Connolly et al. (1990) also examined the anonymity component of GSS. Connolly et al. (1990) noted some of the concepts and concerns previously noted about GSS. They found that a group may provide encouragement and reward for effective contribution as noted in the brainstorming literature developed by Osborn (1957).

Additionally, working in a group may inhibit a contributor as noted by Collaros and Anderson (1969). Also, combining the individual contributions into a group decision could lead to free riding as noted by Kerr and Brunn (1981). Group processes also brought the possibility of production blocking as participants waited to voice their opinions and possibly forgot their ideas (Lamm & Trommsdorff, 1973).

Connolly et al. (1990) selected 72 undergraduate business students to participate in an experiment to study anonymity and evaluative tone on GSS participants. Placed within the student participants were certain individuals who were told only to use certain phrases from a list developed by the researchers. For example, these individuals would make either positive or negative comments such as "Good idea", "I think that will work", and "I agree with you" (Connolly et al., 1990, p. 693). Other individuals were told to make negative comments such as "Bad idea", "This is a terrible alternative", and "That wouldn't make much of a difference" (Connolly et al., 1990, p. 693).

The findings of the study showed that groups generated the most output when members were anonymous to one another, and when the evaluative tone was critical instead of supportive (Connolly et al., 1990). Connolly et al. (1990) noted that critical comments about an idea caused the individual submitting the idea to do further development of that idea. The anonymity allowed the participants to bring the idea to the group while the evaluative tone determined the degree of work associated with developing fully the idea (Connolly et al., 1990).

Nunamaker et al. (1991a) also noted the importance of anonymity in their study of utilizing GSS for negotiating groups. Their study mentioned many of the benefits already noted regarding anonymity such as providing comments without fear of embarrassment, challenging other's comments, or even the ability to change an opinion without fear of embarrassment (Nunamaker et al., 1991a). The anonymity element was also found to encourage participants to be more critical of their anonymous counterparts.

One important concept noted by Nunamaker et al. (1991a) was that the concept of anonymity can change based upon a group's history. If a group had been together for a period of time, it becomes possible, in some cases, to identify the originator of some comments. When this occurred, the anonymity element was lost (Nunamaker et al., 1991a). Additionally, it was easy for participants working in the same room to observe who was typing and who was not. Again, in this type of environment, anonymity could quickly disappear (Nunamaker et al., 1991a).

Wilson (1994) also investigated the anonymity component while utilizing a GSS. Wilson (1994) found that while performing an idea generating task, anonymous groups composed of business professionals generated: (a) more total comments, (b) more unique ideas, and (c) ideas of higher rarity than did identified groups.

GSS and Group Size

Group size is another of the EMS components that must be carefully established (Dennis, Nunamaker, & Vogel, 1991). It is vital to examine the group size in relation to the task that will be performed. Much research documents the impact of group size on the outcome of meetings (Hare, 1981).

The issue of GSS and group size was also addressed by Gallupe et al. (1992). This study used 2, 4, and 6 person groups in one study and 6 and 12 person groups in another. The finding was that the larger groups in both brainstorming experiments generated more unique and high quality ideas than did the smaller groups. Additionally, participants were more satisfied with the process when they used electronic brainstorming than when they used manual brainstorming (Gallupe et al., 1992). Gallupe et al. (1992) interpreted these results as showing that electronic brainstorming reduced production blocking and evaluation apprehension particularly in large groups.

Nunamaker et al. (1991a) also found that group size played an important role in GSS use. Their study found that larger groups outperformed smaller groups in all cases. The results of user satisfaction based upon group size was mixed, with no clear finding. The larger groups may also have process gains as a result of synergy from the larger number of members (Nunamaker et al., 1991a; Nagasundaram & Dennis, 1993; Gallupe et al., 1992).

Dennis and Valacich (1994) also investigated GSS and group size. Their study utilized twelve 3-member groups, five 4-member groups, ten 9-member groups, seven 12-member groups, five 18-member groups, and 103 participants working individually. As a result of this study, Dennis and Valacich (1994) found that the ideal GSS group size were the large groups (12 and 18 member groups). Having all members of the one large group work together generated the most ideas. Working in many small sub-groups was least effective and working in nominal groups fell between the other two groups (Dennis & Valacich, 1994).

In the traditional verbal media, process losses also increased with group size (Diehl & Stroebe, 1987; Jablin & Seibold, 1977). Dennis and Valacich (1994) noted that the electronic media reduced the rate of process loss with its use of parallel communication, anonymity, and synergy. Dennis and Valacich (1994) also noted that the differences in the groups may have been caused by the communication process the groups chose to use. Again, the GSS technology provided another channel of communication (Cherry, 1978). One conclusion was that the electronic media contributed to a different balance of process gains and losses than did the verbal media (Dennis & Valacich, 1994).

Tasks, Incentives, and GSS

The task performed by the EMS groups must also be examined (Dennis, Nunamaker, & Vogel, 1991). This is perhaps one of the most important aspects of any GSS experiment. The task must be one that is familiar to the participants such as: (a) improving the parking problem at a local college, (b) improving campus security, or (c) generating unusual uses for common objects. The task must also be clear to the participants since it is not unusual for the group not to understand the task (Dennis et al., 1991).

Dennis et al. (1991) noted the importance of providing incentives to the participants in EMS experiments. Without incentives, the group participants may not be properly motivated since they have no stake in the outcome (Dennis et al., 1991).

Chidambaram, Bostrom, and Wynne (1991) noted some of the concerns voiced by Dennis et al. (1991) and investigated further. Specifically, Chidambaram et al. (1991) examined the thought that groups have a past and a future. They argued that current research simply investigated only single group sessions. This study examined two issues: (a) the impact of computer support on the development of decision making groups and (b) the patterns of development between computer supported and manual groups (Chidambaram et al., 1991).

Chidambaram et al. (1991) found that groups with computer support and those without computer support showed different development patterns over time. This study found that the ability to manage conflict and the degree of cohesiveness were both higher for non-computer support groups during the first session. However, as the experiment continued, GSS groups handled conflict better and became more cohesive than the manual groups (Chidambaram et al., 1991). Therefore, examining groups over time becomes an important consideration.

User Attitudes Toward GSS

Zigurs, DeSanctis, and Billingsley (1991) examined the attitudes regarding the use of a GSS by group participants. Again, students were used as participants in this experiment. The findings of this study showed that as participants became more pressed for time, they resorted to manual methods with which they were familiar (Zigurs et al., 1991). Some of the groups were actually operating under a "negative learning curve" (Zigurs et al., 1991, p. 64). In other words, the more they learned about the technology, the more they resisted using it. One group did not use the GSS because they "didn't have time to be that organized" (Zigurs et al., 1991, p.64).

It appeared that the groups that used the GSS followed a cycle of experimentation (Zigurs et al., 1991). There were factors that contributed to GSS usage or rejection which included: (a) resistance and inadequate learning by users, (b) perceived mismatch of the technology with the task, (c) real and perceived system inadequacies, and (d) external events (Zigurs et al., 1991).

Sambamurthy and Chin (1994) also examined the effects of group attitudes toward GSS designs. The results of this study showed that: (a) variations in the GSS designs impacted the decision making performance of the GSS groups, (b) group perceptions about the usefulness and ease of use of the GSS influenced how extensively the group would use the GSS, and (c) the amount the GSS was used had a significant impact on the group's decision making performance (Sambamurthy & Chin, 1994).

Kelly and Karau (1993) studied the constraints that time limits placed upon the idea generation process. Their study found that short initial time limits led to faster rates of performance, but lower creativity, than did long initial time limits. The results of their study led them to the conclusion that increased time pressure increases creativity over trials in their decreasing time limit series. Therefore, it is vital to examine group performance over time (Kelly & Karau, 1993).

User Acceptance of GSS (1990s)

Poole and DeSanctis (1990) noted that no matter what features are built into a computer system, users adapted systems to their needs, resisted systems, or refused to use the computer systems entirely. Therefore, when groups are presented with GSS technology, they will form opinions regarding the usefulness of the technology (Sambamurthy & Chin, 1994; Weick, 1990). These opinions were formed as a result of past experiences, training, and related information that was provided to them about the GSS (Poole & DeSanctis, 1990). It was also interesting to note that these social influences operated strongest when an individual encountered an ambiguous situation (Thomas & Griffin, 1983). This is precisely the situation GSS group members often encounter.

It logically follows that if user attitudes impact the use of GSS technology, it would be appropriate to study the roles of group members involved in GSS. Zigurs and Kozar (1994) explored the roles of participants in computer supported groups. The findings of their study showed a mismatch between the role expectations of meeting initiators and meeting participants. In only 4 of 12 role types was there at least a 50 percent match between the meeting initiator's and participant's expectations regarding the role that would be filled by the participant (Zigurs & Kozar, 1994). Zigurs and Kozar (1994) noted that this may explain why meetings often do not develop as they were planned.

Another finding in this study was that the GSS technology itself was perceived by group participants to fill several roles (Zigurs & Kozar, 1994). Group participants found that the technology filled roles of both gatekeeper and motivator. The participants also viewed the technology as supplying a type of group building support (Zigurs & Kozar, 1994).

GSS and Communication Theory

Zigurs, Poole, and DeSanctis (1988) examined GSS from a different perspective. Their research approached GSS from the point of view that it was rooted in theories of communication. Zigurs et al. (1988) approached GSS using the essentials of any communication system which included a source, a channel, and a receiver (Shannon & Weaver, 1949; Cherry, 1978). Shannon and Weaver (1949) noted the impact of noise on the communication channel. This depiction is noted in Figure 15.

GSS attempts to reduce the amount of noise that enters the communications channel. This is accomplished through a variety of GSS techniques. Srinivasan Rao and Jarvenpaa (1991) note that GSS use of organized turn taking, an increased number of alternative channels, and the number of media lead to better group performance and provide a link between communication theory and the computer support of groups. Srinivasan Rao and Jarvenpaa (1991) note this link between communication theory and the computer support of groups in their development of the model noted in Figure 16.

Zigurs et al. (1988) also noted the importance of nonverbal communication as part of the process. The main point of investigation in this study conducted by Zigurs et al. (1988) was an investigation of the influence that group members attempted to exert over other members through various channels. Therefore, channels were important since they could be used to exert influence over group members (Zigurs et al., 1988). Although DeSanctis and Gallupe (1987) argued that a GSS provided group members with the opportunity to participate more equally, Zigurs et al. (1988) investigated the possibility that a GSS simply provided another channel for exerting influence on group members.

Zigurs et al. (1988) used students to participate in their experiments. The finding was that the computer supported group had a significantly more even distribution of influence than did the manual groups. The results supported the current thought that use of a GSS should encourage even participation in group decision making (Zigurs et al., 1988).

Dennis, George, Jessup, Nunamaker, and Vogel (1988) also noted the importance of communication as part of the GSS. Their study proposed an electronic meeting system (EMS) that provided another communication channel in the process of conducting meetings and going beyond simply reaching decisions (Dennis et al., 1988). EMS moved beyond the decision making function which was implied in the term "group decision support system." An EMS could provide a foundation for idea generation, planning, and creativity (Dennis et al., 1988).

The EMS should also subscribe to the "toolkit" approach noted by Liang (1988). Although Liang (1988) specifically advocated the use of models as tools, the approach was somewhat similar to that offered by Dennis et al. (1988). Rather than being specific applications, an EMS should contain tools that could be adapted to a variety of situations. Some examples of tools contained in an EMS would be the following: (a) session director, (b) electronic brainstorming, (c) issue analyzer, (d) voting, (e) topic analyzer, (f) policy formation, (g) organizational infrastructure, (h) stakeholder identification, and (i) alternative evaluator (Dennis et al., 1988).

Another area discussed by Dennis et al. (1988) was the environment in which the EMS would be used. A GSS has been used in a variety of group sizes (DeSanctis & Gallupe, 1987), in distributed decision making (Thomas & Burns, 1982), and face-to-face vs. non-face-to-face meetings (Jelassi & Beauclair, 1987). Since the environments could be so different, Dennis et al. (1988) noted that consideration must be given to the design of the EMS facility. Elements to be considered included the floor plan of the room, public information display, workstation design, ergonomics, and support issues.

GSS and Human Information Processing Theory

Norman (1976) noted the limitation of human information processing theory. The limits of human information processing ability can be extended, however, by either forming groups or providing technological assistance. When groups are formed, communication must take place between members. This communication process uses mental resources and detracts from the increased informational processing ability that came within group formation (Norman, 1976). By introducing a computerized GSS at this point, it is argued that the mental resources of the group can be extended

(Srinivasan Rao & Jarvenpaa, 1991). Norman (1976) depicted the simple model of human information processing theory noted in Figure 17.

The model noted in Figure 17 is intended to depict the positive correlation between available mental resources and human performance (Norman, 1976). Interjecting GSS would lead to the model found in Figure 18 which depicts linking human information processing to computer support of groups as proposed by Srinivasan Rao and Jarvenpaa (1991).

Newell and Simon (1972) noted that humans are "information processing systems" (p. 465). As such, humans have commonalities that produce common characteristics among all human problem solvers. Newell and Simon (1972) noted the following characteristics of humans as information processing systems (IPS):

1. The human IPS is a serial system: it can only execute one elementary information process at a time.

2. The human IPS includes a short-term memory of a very limited capacity of about 5 to 9 symbols (Miller, 1956).

3. The human IPS contains long-term memory that has unlimited capacity and is organized associatively. It contains symbols and symbol structures.

4. Symbols represent "chunks" (p. 465) of information. A chunk is a single unit of information of any arbitrary degree of complexity, size, and organization. Symbols need

to be searched for and transferred from long-term memory to short-term memory before they can be used.

5. An external memory may be provided to extend the virtual capacity of short-term memory. External memory could be paper or electronic.

Nagasundaram and Dennis (1993) took the work of Newell and Simon (1972) and applied it to idea generation. Newell and Simon (1972) noted that "an idea is a product of a thought process" (p. 466). They further observed that the process of idea generation is really a cognitive act that involves information processing and information access. As such, Nagasundaram and Dennis (1993) offered some implications of the IPS perspective for idea generation which include the following: (a) individuals can perform only one kind of process at a time, (b) any idea that exceeds the chunk capacity of short-term memory will not be fully stored, (c) when multiple events are occurring, interference between events will result in a loss of ideas with respect to the individual, and (d) some form of external memory will enhance idea generation be extending short-term memory.

Nagasundaram and Dennis (1993) note that use of a GSS can provide "cognitive assistance" (p. 470) to those engaged in idea generation. Some mechanisms such as parallel input, collective memory, and serially retrievable output together work around some of the limitations of the IPS noted earlier (Nagasundaram & Dennis, 1993).

Time Pressure and Group Productivity

Time Pressure: An Overview

There have been many studies that examine the impact of stress on decision making (Beier, 1951; Smock, 1955; Loomins, 1960; Broadbent, 1971; Janis & Mann, 1977; Ben Zur & Breznitz, 1981; McGrath, 1984; Kelly & Karau, 1993). Many of these studies have investigated the impact of time on individual decision making, however, few studies have examined the impact of time constraints on group productivity. The studies that have investigated time constraints and group productivity have investigated using a variety of approaches.

Newell and Simon (1972) noted that problem solving involves a search in a problem space. This problem space contains not only the correct solution but also all possible solutions. Bowden (1985) took this work further and noted that time is an important consideration when dealing with this problem space issue. Bowden (1985) noted that it is easier to locate answers in the problem space if you have sufficient time to search.

Wright (1974) found that group members under time pressure would systematically place greater weight on negative evidence than those group members not under time pressure. Wright (1974) linked his work to the process loss of information overload as noted by Newell and Simon (1972) and Hiltz and Turoff (1985). Wright (1974) found that process losses associated with information overload could be caused by either: (a) increasing the amount of data with which a person must cope, or (b) decreasing the time available for dealing with the information.

Wright (1974) used 210 undergraduate students utilizing judgment type tasks. Given a variety of information about cars, the students were told to select the car they would purchase upon graduation. This study noted that group members accentuate negative evidence when leisurely processing of the information is not permitted.

Christensen-Szalanski (1980) conducted two experiments using 10 and then 12 undergraduate students who were asked to analyze six 4-page case studies. This study found that time pressure forces the problem solver to use less costly and potentially less accurate strategies. The problem solver used the strategy that could be utilized within the time constraint and produced the greatest personal benefit.

Zakay and Woller (1984) examined the relationship between time constraints and training. This study used 60 university students to examine this relationship. The results of the study found that time pressure has a destructive effect on decision effectiveness. The study also found that high effectiveness diminished rapidly when time pressure was applied. Zakay and Woller (1984) reported that under time pressure old habits are activated. These old habits tend to overrule newly learned skills.

Isenberg (1981) noted that all of the studies that examine time constraints and group decision making fall under two broad categories: (a) studies that deal with the effects of time pressure on group process and structure or (b) studies that deal with the effects of time pressure on group productivity. This study found that time pressure caused increased vertical structuring within groups. Isenberg (1981) defined vertical structuring as having the following characteristics: (a) decision-making will become more centralized and autocratic, (b) air-time will be shared less equally; and leadership will become more "salient" (p. 120).

Time Pressure and Negotiation

Several studies have investigated the relationship between negotiation and time pressure. Frye and Stritch (1964) used 100 undergraduate students to investigate this connection. The task involved the rank ordering of solutions to case-history problems. This study found that time pressure led to significantly higher initial agreement. Group members would acquiesce more in order to achieve group consensus.

One interesting finding of this study was that group members under time pressure are less inclined to change their rankings after the group discussion. It was noted by Frye and Stritch (1964) that the reduced discussion time due to the time pressure led to resentment and possibly rejection of the group decision. The personal reaction of group members appeared to be: "If you won't listen to my opinion, or if I don't get a chance to express it because of lack of time, I will not accept your opinion" (p. 142).

Pruitt and Drews (1969) found that time pressure causes group members to be less demanding and more conciliatory in negotiation situations. Their study used 80 undergraduate students to participate in an experiment where two parties must agree on one of a set of alternatives or face consequences associated with not reaching agreement. This experiment involved two parties making offers, each hoping to get the greatest personal gain.

Yukl, Malone, Hayslip, and Pamin (1976) also investigated this issue of time as related to negotiation. Their research used undergraduate students who were told that the bargaining game used in the experiment would be a test of their skill as a negotiator. The objective of the game would be to reach a settlement at a price providing a large personal payoff. This study found that there was less truthful communication under high time pressure and that time pressure inhibited problem solving.

Time Pressure and Entrainment

The concept of entrainment as it is related to group performance is a relatively new area of research. The entrainment concept when applied to group performance was initially investigated by Kelly and McGrath (1985). Their definition of social entrainment is "a concept that refers to the altering of social rhythms or patterns by external conditions (such as time limits), and to the persistence of such new rhythms over time" (p. 395).

Their 1985 study of entrainment utilized 512 undergraduate students. The students were given two tasks consisting of either production, planning, or discussion tasks as identified by Hackman (1966). Production tasks required the group to generate ideas. Discussion tasks required the group to evaluate an issue and planning tasks required the group to describe a plan of action to achieve a goal (Kelly & McGrath, 1985). Dimensions that assessed both quality and quantity of idea generation were selected from those developed by Hackman, Jones, and McGrath (1967). The groups were given two time periods in which to work. One time period was 10 minutes while the second time period was 20 minutes. The time periods were varied between groups (Kelly & McGrath, 1985).

At the conclusion of the experiments, the group members were asked to identify the main source of stress they experienced during the experiments. This assessment was completed through the use of post-test questionnaires. The format of the data collection was free response. All responses were then classified into one of two categories: (a) time pressure, or (b) all other responses (Kelly & McGrath, 1985).

This study also utilized two judges rating each of the dimensions utilized in the research. The judges used a 7-pile sort-resort technique as noted by Hackman et al. (1967). As part of the research, the inter-rater reliability of the judges was assessed (Kelly & McGrath, 1985).

This study found that time constraints do influence group performance. The shorter time period led to higher rates of performance but at a cost to quality. The 20 minute time period generated higher quality ideas than those generated by the 10 minutes period groups (Kelly & McGrath, 1985). This study also supports the concept of social entrainment. Kelly and McGrath (1985) found that persistence of interaction and performance patterns continued even when the situational conditions (time pressure) was altered.

Kelly, Futoran, and McGrath (1990) continued the entrainment research. They reported the results of seven studies that they completed which investigated the entrainment concept. Their method was similar to the previous study by Kelly and McGrath (1985). All of the studies utilized undergraduate students who received course credit for their participation. The various studies used groups who operated under differing time periods. These periods were varied among the groups.

The tasks used in these studies included the unusual-uses tasks that were identified by McGrath (1984). These tasks required groups to develop unusual uses for common items. For each of these time trials the groups consisted of either dyads or triads. The time constraints for these seven experiments varied between 5 minutes and 20 minutes depending upon the task used (Kelly et al., 1990).

This study found that entrainment effects can be divided into two types: (a) initial trial effects, or (b) trial-to-trial carry-over. This study found that when investigating rate of ideas, initial trial effects show that short initial trials lead to faster rates of performance while long initial trials lead to slower rates of performance. The trial-to-trial carry-over effects on rate of idea generation showed groups that experienced difficulty as related to capability seemed to slow down their rate on subsequent trials. Groups that experienced difficulty as related to capacity seemed to speed up rates on later trials (Kelly et al., 1990).

Kelly et al. (1990) discussed these concepts of capacity and capability. Capacity problems generally involve issues of either time, load, or difficulty level. If a group is facing capacity problems associated with time pressure, they will attempt to compensate for the capacity problem by speeding up their rate. The concept of entrainment is observed when the group continues this pace in a subsequent trial even when the time limit has been relaxed (Kelly et al., 1990). Kelly et al. (1990) noted that groups operating under classic brainstorming instruction would most likely experience capacity problems as they attempt to obtain as many ideas as possible.

Problems associated with capability are generally defined as tasks that are "beyond the unit's current or momentary task performance capabilities" (p. 287). The method groups use to deal with this problem is not to speed up their work but rather to slow down. This slow down allows the group more processing time for the task (Kelly et al., 1990).

Kelly et al. (1990) found that on the initial trial, groups work at a faster rate (production rate) the shorter the initial time limit and the higher the task load. The study also found that groups that worked on the unusual-uses tasks and began with the short time period will generate ideas at about the same rate by the end of the time period as in the beginning. It is thought that these groups will only experience a capacity problem and they leave the time period believing that they will simply complete as many ideas as the time period permits. If the next longer time period has problems of the same general difficulty and at least the same problem load, the group is likely to work at nearly the same rate on the longer time period in order to solve the capacity problem experienced by the group during the first time period (Kelly et al., 1990).

Kelly et al. (1990) also provided a post-test questionnaire to group members. The questionnaire asked participants "how much they had felt stress" during the time period (p. 308). The word "stress" was not defined. The questionnaire also asked the participants to note the cause of their stress. Over two-thirds of the group members who answered that question noted their stress was caused by time pressure. This study also noted a negative relationship between rate of idea generation and quality of performance (Kelly et al., 1990).

Kelly and Karau (1993) have completed the most recent study investigating time pressure and entrainment. Their study was designed to investigate both the "initial and persisting effects of time on group creativity" (p. 179). This study utilized the unusual-uses tasks that have traditionally been used to measure group creativity when utilizing brainstorming rules (Lamm & Trommsdorff, 1973; Diehl & Stroebe, 1987).

Kelly and Karau (1993) used 99 undergraduate students to participate in the experiments. The students were placed into triads to complete the group work. The experimental design was a 3 (trials) X 3 (time limit order) factorial. The three orders of time limits were 4, 8, and 12 minutes; 8, 8, and 8 minutes; or 12, 8 , then 4 minutes. This study also utilized common objects as the materials for the research. These materials were taken from Kelly et al. (1990).

Kelly and Karau (1993) used both quantity and creativity-dependent measures. They calculated the rate of use as the number of uses generated by the group per minute. Scale values were determined for both creativity and feasibility of ideas. These scale values were determined through a seven pile sort-resort procedure as identified by Hackman et al. (1967). Inter-rater reliability was also calculated as the correlation between the judges' ratings (Kelly & Karau, 1993).

As a part of this research, two judges created 14 hierarchical categories that sufficiently categorized each of the uses generated by the groups. This categorization is similar to that of Vroom et al., (1969) and Lamm and Trommsdorff (1973). A variety of calculations could then be completed including the mean number of categories produced, number of categories generated per minute, and number of uses generated per category (Kelly & Karau, 1993).

During the experiment, two three-person, same-sex groups were utilized. Participants were randomly assigned to both seat positions and groups. A facilitator instructed the group, giving the following information: (a) the purpose of the study was to examine creative idea generation in three-person groups, (b) the groups were asked to generate creative and unusual uses for the common objects, and (c) the groups were instructed to focus on both quantity, originality, and feasibility of the uses. The groups were then given common objects and asked to produce 15 uses for each object. Just prior to the trial the groups were given the time constraint. At the conclusion of each trial, the groups were asked to complete a questionnaire containing questions on both performance and members' perceptions of each trial (Kelly & Karau, 1993).

This study found that on the first trial, rate and creativity may be inversely related. The study also found that faster rates led to lower creativity while slower rates led to higher creativity (Kelly & Karau, 1993). Across-trial ratings, however, show that creativity increased over the three trials in the 4, 8, and 12 minute session and in the 12, 8, and 4 minute session. For the decreasing time series, there is a gain over trials in creativity and rate. Therefore, time pressure does not necessarily lead to reduced creativity in group performance (Kelly & Karau, 1993).

GSS and Group Productivity

As noted earlier, the area of GSS and its relationship with the concept of productivity began with the work of Osborn (1957). Osborn (1957) developed the four components that are essential to brainstorming theory which were previously noted. As reviewed earlier in this chapter, Osborn's (1957) work was quickly followed by that of Taylor et al. (1958) whose work was the first conducted to test Osborn's (1957) theory. Taylor et al. (1958) found that nominal groups produced nearly twice as many different ideas as the real groups. Faust (1959), however, reported that there are circumstances in which groups could be expected to be more productive than individuals. Steiner (1966, 1972) also identified process gains and losses associated with group settings.

The concept of process gains and losses has been investigated by a variety of researchers with varied results (Vroom et al., 1969; Bouchard & Hare, 1970; Street, 1974; Jablin, 1981; Diehl & Stroebe, 1987; Dennis, Nunamaker, & Vogel, 1991; and Gallupe, Cooper, Grise, & Bastianutti, 1994). In fact, there have been over 80 studies limited to verbal idea generation that found nominal groups to generate more unique ideas of higher quality than intact groups (Dennis & Valacich, 1994). To examine some of these studies refer to the work of Jablin and Seibold, 1978; Lamm and Trommsdorff, 1973; Hill, 1982; and Diehl and Stroebe, 1987.

Many of these studies have shown that Osborn's (1957) claims have not been precise. In fact, many studies have noted that nominal groups (individuals generating ideas on their own which are later combined) generate more ideas than the same number of individuals in face-to-face interacting groups (Gallupe, Bastianutti, & Cooper, 1991).

Prior to the use of technology, specifically GSS, the majority of published studies regarding brainstorming show that brainstorming groups of four or more participants produce significantly fewer ideas than do nominal groups (Gallupe et al., 1991). Diehl and Stroebe (1987) proposed three possibilities to explain these results. These three were the following:

1. Production Blocking: Only one member of a group can talk at any one time. While participants are waiting their turn they tend to forget or get "talked out" of their ideas.

2. Evaluation Apprehension: Group members are reluctant to submit poorly developed or unpopular ideas for fear of group criticism.

3. Social Loafing: Group members invest less effort in group projects than they do in individual work. Individuals brainstorming alone work harder and produce more ideas than do group members who can lie back and leave the work to others (Connolly, Routhieaux, & Schneider, 1993).

The addition of technology has provided the foundation for a number of researchers to carry forward the investigation of Osborn's (1957) brainstorming theory and Steiner's (1966, 1972) theory. Using GSS, Gallupe et al. (1991) found that electronic groups were more productive than nonelectronic groups. Gallupe and Cooper (1993) found that "electronic brainstorming is a better way to generate ideas than both traditional brainstorming and nominal groups (individuals working alone)" (p. 27). Dennis and Valacich (1994) also found that "the new electronic media warrant new rules for idea generation" (p. 734). It is interesting to note that Nagasundaram and Dennis (1993) found that "groups" working with GSS idea generation are not so much groups as they are a collection of individuals working intact.

Dennis and Valacich (1994) also noted that the ideal work group in the GSS environment is not the nominal group but rather the intact group. As shown here, researchers are finding that the new technology (GSS environment) has removed some of the process losses investigated by Steiner (1966, 1972) and assisted by providing process gains.

Inconsistencies Across GSS Studies

The use of GSS has had mixed results regarding its effectiveness in group settings. There have been positive results in the work of McGoff et al. (1990), Chidambaram et al. (1991) and those named previously in this review. Watson et al. (1988) found negative results in his GSS related study. It is argued that it may be appropriate to develop new theory-based models to support on-going GSS research (Srinivasan Rao & Jarvenpaa, 1991).

Srinivasan Rao and Jarvenpaa (1991) argued that GSS research had moved in other directions without first reconciling the inconsistencies in the various studies regarding the effectiveness of GSS. Srinivasan Rao and Jarvenpaa (1991) noted that many of the inconsistencies in empirical results were caused by a lack of theoretical models for developing hypotheses and interpreting research results. By providing theoretical models that can be used by all, the results that appear to be mixed concerning the value of a GSS may actually not be that far apart.

Inconsistencies Across Time Pressure Studies

Research has just begun in the area of time pressure as it is related to group creativity. There are few studies that actually investigate these relationships (Kelly & McGrath, 1985; Kelly et al., 1990; Kelly & Karau, 1993). To date, the studies investigating time pressures and entrainment issues have similar findings. However, the most recent study by Kelly and Karau (1993) discovered a surprising effect. This effect was that creativity of uses increased in not only the 4, 8, and 12 minute periods but also in the 12, 8, and 4 minute periods. Further investigation of this effect is warranted based upon the findings of Kelly and Karau (1993).

There are additional studies that reported individuals working under time pressure function at a faster rate, although frequently at a cost to quality (Smith et al., 1982; Yukl et al., 1976; and Kelly, 1988). There is also early research that indicates that moderate levels of time pressure may actually increase performance (Pepinsky et al., 1960).

Conclusion

The utilization of group support systems is steadily increasing. Group support systems have been used in the past to generate ideas that many managers have attempted to generate during traditional face-to-face meetings. The use of GSS allows idea generators and decision-makers to by-pass some of the traditional approaches and utilize concepts such as parallel idea generation, multiple monologues, and anonymity when contributing within the meeting. The use of a GSS removes some of the process losses that have been noted in the literature (Newell & Simon, 1972; Steiner, 1972; Lamm & Trommsdorff, 1973; Jablin & Seibold, 1978; Diehl & Stroebe, 1987). This does not come without its problems, however. Changes in technology can sometimes occur before changes in the social norms or organizational culture can take place.

There are further areas for research in time pressure studies. One area that warrants continued investigation is Steiner's (1972) productivity theory which notes that productivity is based, in part, on the process that is utilized by the group. By utilizing GSS technology, the process of time pressure can be further studied by examining the rate of ideas generated over time, idea creativity, and idea chaining. The technology associated with the use of a

GSS can provide new tools for research in this area while further investigating Steiner's productivity theory (1972).

Additionally, several studies investigating time pressures have measured group productivity. (Kelly et al., 1990; Kelly & Karau, 1993) Current GSS technology allows further investigation of productivity in terms of precise computer measurement of idea generation rate. Dennis et al., (1995) have started new research in this field. To date, no research has been published that indicates any investigation of idea chaining even though Osborn (1957) discussed the benefits of idea "piggybacking" almost 40 years ago.

Additionally, some research has placed ideas into hierarchical categories to further investigate the range of decision alternatives produced by groups, however, further investigation is warranted (Lamm & Trommsdorff, 1973; Kelly & Karau, 1993). Dennis et al. (1997) are the first to take this category concept further and have pioneered the concept of idea chaining. Although briefly noted in their research, this concept should be further investigated to determine how ideas build within groups.

The popularity of time pressure study is increasing. Utilizing a GSS to further study this issue can provide valuable information that may result in significant changes in the methods used to conduct business meetings. The GSS area provides many opportunities to further investigate the impact of time pressure on group productivity, creativity, and the chaining of ideas.

CHAPTER III

METHODOLOGY

This chapter discusses a variety of issues including the following: (a) the use of a GSS during research, (b) the research setting and procedures, (c) materials to be used, (d) measures, (e) justification of measures, (f) the independent variables, (g) the dependent variables, (h) hypotheses, (i) the post-test questionnaire, (j) post-test questionnaire reliability issues and (k) proposed data analyses techniques.

The research setting and procedures section discuss the experimental setting including the subjects utilized, the procedures and administration of the research, and the GSS hardware and software used in the research.

Research Design

To further investigate Steiner's (1972) productivity theory noting the relationship of processes to productivity, the following question is offered for testing: does the addition of time pressure into group processes impact group productivity, idea creativity, and idea chaining? Figure 19, developed by the author, provides a visual representation of the research question.

The research design followed that used by Kelly and Karau (1993) in their investigation of time pressure utilizing face-to-face groups. This dissertation, however, utilized a GSS rather than the more traditional face-to-face groups.

One hundred and two undergraduate students were utilized as participants in this study. These students received course credit totaling 5 percent of their course grade for participating in the research. This 5 percent incentive has been used as a standard during GSS research involving undergraduate students (Zigurs et al., 1988; Sambamurthy & Chin, 1994).

The students were placed into same-sex, 3 member groups during the experiment. Gender was evenly distributed over conditions. Same-sex, 3 member groups have been used extensively in similar research (Watson, DeSanctis, & Poole, 1988; Kelly & Karau, 1993; Gallupe et al., 1994; Dennis & Valacich, 1994).

The research is a mixed design, utilizing one fixed effect (group) and two random effects (time and task).

Three time periods and three time orders were utilized in this study. The three time limit orders used were 3, 6, and 9 minutes; 6, 6, and 6 minutes; and 9, 6, and 3 minutes. The 6, 6, and 6 minute trials were used as a control condition as noted by Kelly and Karau (1993).

The three time limits were selected based upon the work of the following researchers. Kelly and Karau (1993) examined the impact of time pressure utilizing face-to-face groups. During that study three time limits were used. Those three time periods were 4, 8, and 12 minutes. The use of the 50 percent intervals between the time periods follows the generally accepted treatment. This generally accepted rule is that high time pressure groups are given 50 percent or less of the time considered sufficient for completing the task (Hwang, 1994). This dissertation, however, utilized a GSS therefore, the length of the time periods were adjusted to account for the use of computer technology.

Gallupe, Bastianutti, and Cooper (1991) found that GSS supported groups solving idea generation tasks generated 25.62 percent more ideas than groups not utilizing a GSS. As previously noted, Kelly and Karau (1993) found that the 8 minute time period used in their study was optimal for providing sufficient time to generate ideas for tasks utilized in their research. If the time periods used in the dissertation were to remain constant with those used by

Kelly and Karau (1993), there would be no compensation for the GSS technology. Therefore, to adjust for the impact of technology on the rate of idea generation noted by Gallupe et al. (1991), the time periods utilized for this dissertation were 3, 6, and 9 minutes rather than 4, 8, and 12 minutes used by Kelly and Karau (1993).

The time periods used in this dissertation represent a 25 percent reduction in the time period rather than the 25.62 percent identified by Gallupe et al. (1991). The 25 percent rather than 25.62 percent time reduction was used simply to allow the use of even minute time periods. There is no evidence in prior research that supports the use of time periods other than those designated by even minutes such as 3, 6, and 9 minutes. Prior research also utilized the three time period design with a 50 percent time increase added beyond the middle time period (Kelly & Karau, 1993).

The experiment instructions were given by a facilitator as noted in a variety of prior GSS studies (Clawson, 1993; Dennis & Valacich, 1994). The general instructions were read by the facilitator to the participants from the script found in Appendix A. Additionally, the facilitator read specific instructions to the participants prior to each of the three trials. These instructions are found in Appendices C, D, and E. At the conclusion of all three trials, the facilitator read the concluding script found in Appendix G.

After each of the three time trials, the facilitator administered a post trial questionnaire to each group participant. The same questionnaire was administered after each of the three trials. This questionnaire can be found in Appendix F.

Each group was given a creativity task as defined by McGrath (1984). These tasks are designed to generate ideas as opposed to seeking a single, correct answer. The tasks for this research are taken from the study conducted by Kelly and Karau (1993).

Use of a GSS

A computerized group support system (GSS) was used as the media for idea collection. The GSS facility at Nova Southeastern University was the site for the experiments.

The warm-up exercise noted in Appendix B was utilized prior to the actual experiment. Pruitt and Drews (1969) noted the importance of a warm-up period prior to the start of an experiment. The participants utilized the "thumb" exercise as identified by Taylor et al. (1958, p. 28). This exercise is designed to familiarize participants with the GSS hardware and software that will be used during the actual experiment. The research participants were permitted to practice for 6 minutes, which is the same amount of time given to the control groups in the experiment. No prior research indicates any optimal time period for practice exercises. The practice time of 6 minutes was selected based upon pre-test data. The pre-test data indicated that the 6 minute period provided adequate time to complete an idea generation task such as that used for the practice exercise.

Computer Hardware and Software

The GSS computer software that was used for this study is GroupSystems for Windows. This software presents a horizontally split screen to the user. The ideas of other participants are displayed on the top half of the screen. The lower half of the screen allows the user to type in his/her ideas. The software can be controlled and monitored from the leader (facilitator) station located in the front of the decision support room.

The computer hardware used in this study consisted of networked 486 personal computers with color displays. All displays are built into the user's work desk so that participant's cannot observe other user's computer displays.

Materials

Three objects as identified by Kelly and Karau, (1993) were used to generate ideas within the groups. These objects included the following: (a) coffee cup, (b) shoelace, and (c) paper clip. These objects were counterbalanced across conditions and trials as noted by Kelly and Karau (1993).

Measures

Both quantity and creativity-dependent measures were used. Rate of idea generation was calculated as the number of ideas generated by the group in 30 second intervals. The 30 second interval was selected since this is the minimum time period that the GSS software can track participant responses.

Scale values for creativity of each generated idea were determined through a sort procedure noted by Diehl and Stroebe (1987), Gallupe et al. (1992), and Dennis et al. (1997). In this procedure two raters independently sorted all the ideas generated by the groups based upon a five-point scale. The scale ranged from 1 (very low creativity) to 5 (very high creativity). Raters were given definitions for each of the anchor points on the scale.

Following the work of Hackman et al. (1967), an idea was rated as a 1 (very low creativity) to the extent that it is "ordinary, everyday, or usual in content" (p. 389). An idea was rated 5 (very high creativity) if it is "unique, fresh, unusual, surprising, or refreshing" (p. 389).

Following the work of Diehl and Stroebe (1987) and Gallupe et al. (1992), the two raters were defined as in agreement if their ratings were within one point of each other. Reliability was then calculated as the correlation between the ratings assigned by the two independent raters (Diehl & Stroebe, 1987; Gallupe et al., 1992; and Dennis et al., 1995).

The concept of idea chaining was also investigated as part of this research. The chaining of ideas or "piggy-backing" as identified by Osborn (1957) was evaluated by two raters. These raters reviewed sequential ideas and rated the number of ideas chained per 30 second interval.

The raters also reviewed transcripts of the idea generation sessions. Based upon their independent review, the raters classified each generated idea as chained or unchained. The raters based their scoring on Osborn's (1957) definition of chaining as noted in his brainstorming rules. Specifically, ideas within 30 second intervals that indicated the combination and improvement of previously submitted ideas were classified as chained.

Raters used a coding scheme developed by Connolly et al. (1990). This coding scheme required that the independent raters classify each idea as one of thirteen possible categories. Items coded as supportive argument (SA) or solution clarification (SCL) were classified as chained ideas since by definition both of those categories fulfill Osborn's (1957) definition of chaining. This coding scheme developed by Connolly et al. (1990) and associated category definitions can be found in Appendix H.

Following the work of Gallupe et al. (1992), Nunamaker et al., (1991), Connolly et al. (1990), and Diehl and Stroebe (1987), training for the raters consisted of an overview of the rating scale for the experiments. The raters followed the instructions using their "judgment" regarding an idea's creativity, hierarchical categorization, or idea chaining (Connolly et al., 1990, p. 694). Prior research in the area of rater utilization makes no mention of any specific, in-depth rater training procedure.

The use of independent raters to evaluate the work of groups is widely found in prior group studies (Zigurs et al., 1988; Kelly & Karau, 1993; Dennis & Valacich, 1994; Dennis et al., 1995). The correlation between the ratings assigned by the two independent raters was measured as noted in these prior studies.

Additionally, as a measure of group creativity, this study followed guidelines established in prior research regarding hierarchical levels of categorization (Lamm &

Trommsdorff, 1973; Vroom et al., 1969; Kelly & Karau, 1993). Lamm and Trommsdorff (1973) noted that the number of idea categories generated by a group may be a better index of idea creativity than only numbers of ideas.

Therefore, two independent raters created various hierarchical categories for categorizing each of the uses identified by the groups for the various objects. Each identified use was then placed into one of the categories. Following the work of Kelly and Karau (1993) the mean number of categories produced per 30 second interval was calculated.

Justification of Measures

The measures that were used in this research have been used in past research as measures of productivity. The use of rate of ideas generated can be found in the work of Osborn (1957), Bouchard & Hare (1970), DeSanctis & Gallupe (1987), and Kelly and Karau (1993).

The measure of idea creativity has also been used in prior research as a measure of productivity. This can be found in the work of Glover and Chambers (1978), Hare (1982), Nunamaker et al. (1987), and Kelly and Karau (1993). The use of raters establishing idea categories as measures of productivity can be found in the work of Vroom et al.

(1969), Lamm and Trommsdorff (1973), and Kelly and Karau (1993).

The measure of idea chaining has also been used as a measure of productivity in the work of Osborn (1957). However, very little research has investigated this aspect of group interaction.

Post-Trial Survey Instrument

At the conclusion of each of the three time periods, a survey instrument was administered to all participants. Prior research has utilized a post-trial survey instrument to collect data regarding: (a) the impact of the various time periods used, (b) the participant's perception of the effectiveness of the ideas, and (c) the user's satisfaction regarding the process used to generate the ideas (Kelly & McGrath, 1985; Kelly & Karau, 1993; Post, 1993; and Dennis et al., 1995).

Reliability of the Post-Trial Survey Instrument

The survey instrument that was utilized has been used in similar research and has proven to be a reliable instrument (Dennis et al., 1995). The instrument contains fourteen 7-point Likert scale questions and two open-ended questions. The open-ended questions allowed participant's to comment on aspects of the process they liked or disliked.

Dennis et al. (1997) reported that this questionnaire yielded the following alpha results in the three areas assessed: (a) whether the participants had sufficient time to complete the task - alpha = .73, (b) the participant's perception of the effectiveness of the ideas - alpha = .83, and (c) the user's satisfaction regarding the process used to generate the ideas - alpha = .79.

According to Nunally (1978), reliability (Cronbach's alpha) levels of 0.70 are acceptable for exploratory research. The instrument used in this dissertation surpasses that acceptable level. Additionally, similar prior research utilizing questionnaires have conformed to this standard (Jarvenpaa et al., 1988; Davis et al., 1989; Nunamaker et al., 1991; Gallupe et al., 1992; Miranda & Bostrom, 1994). The survey was used with permission of the author, Dennis et al. (1997).

Methodological Procedure

The three person groups reported to the experiment room for a study titled "Creative Use Generation" (Kelly & Karau, 1993). Additionally, group members were randomly assigned to the groups and randomly seated at GSS computer terminals located in the research facility. Four group members were scheduled for each session to make certain that three participants were available for the actual testing. In the event that more than three members were present, the fourth participant was given an idea generation task utilizing a stand-alone personal computer. Any data generated by members not part of the three person groups was not used in this study.

A facilitator notified participants that the purpose of the study was to examine creative idea generation in three person groups. Groups were asked to generate creative and unusual uses for common objects they were shown during each of the three trials of the experiment. Just prior to each of the three trials, the groups viewed the common object they utilized during the trial. The facilitator instructed the groups to develop as many uses as possible for the object.

Groups were also informed of the time limit for each trial just prior to the beginning of the trial. At the conclusion of each 30 second interval, the facilitator told the participants the time that was remaining in the time trial. This was done to increase the awareness of time pressure and has been done in prior time pressure research (Wright, 1974).

Additionally, each group member was asked to complete a post-trial questionnaire consisting of 14 7-point Likert scale questions and two open-ended questions. This questionnaire can be found in Appendix F. The completion of the questionnaire was intended to collect information concerning the research experiment in each of the following areas: (a) the impact of the various time periods used, (b) the participant's perception of the effectiveness of the ideas, and (c) the user's satisfaction regarding the process used to generate the ideas.

The Independent Variables

The independent variable studied was the time periods allotted during the experiment. Three time limits were used during this research. These time limits required each group to work for three periods. The time periods are 3, 6, and 9 minutes; then 6, 6, and 6 minutes; and 9, 6, and 3 minutes. Each group was asked to produce as many ideas as possible regarding uses for the common objects noted in the materials section. The groups were also instructed to follow Osborn's (1957) brainstorming rules. This follows the general experimental design of Kelly and Karau (1993).

The Dependent Variables

This research tested the effects of three differing time periods on the following four dependent variables: (a) rate of uses generated per 30 second interval, (b) creativity of the uses per 30 second interval, (c) the number of categories of uses generated per 30 second interval, and (d) number of ideas chained per 30 second interval.

It is important to note here that although time periods were randomly assigned to groups during the research, it is the fixed 30 second intervals that were utilized when collecting the data. This is further discussed in the dissertation section that discusses fixed and random effects.

Analyses (Statistical Techniques)

The analyses of data followed the research of Kelly and Karau (1993). Trial effects were analyzed utilizing a one-way analysis of variance (ANOVA) with a significance level of 0.05.

The One-Way Analysis of Variance (ANOVA) Technique

This technique is essentially concerned with analyzing the variation that is inherent in data collection. Analysis of variance refers to a set of well-defined procedures for partitioning the total variation of a data collection into its component parts (Kachigan, 1986).

If k represents the number of sample means with which we are evaluating, the null hypothesis can be stated as follows (Kachigan, 1986):

$$H_0: \mu_1 = \mu_2 = \mu_3 = \ldots = \mu_k$$

This null hypothesis supposes that the sample means are all estimates of the same population mean μ. The alternative hypothesis is that at least one of the means differs from the others.

This technique produces an F ratio which is the ratio of the between groups variance estimate to the within groups variance estimate. Each of the two variances forming the F ratio is associated with its own degrees of freedom. The degrees of freedom are often expressed as k-1, where k is equal to the number of groups. The degrees of freedom refers to the number of means that are free to vary about the overall mean (Kachigan, 1986). Kachigan (1986) also noted that the degree of freedom associated with the within groups variance estimates are equal to:

$$\sum n_j - k$$

In this case, n_j equals the sample size for the jth group. This may be explained as the sum of the individual group sample sizes (which comprises the total sample size) minus the number of groups. One degree of freedom is lost for each group mean that is calculated (Kachigan, 1986).

Finally, a significance test of F must be conducted to determine if the value is statistically significant. It is assumed in this technique that there is homogeneity of population variances when evaluating the F ratio. Without this assumption, rejection of the null hypothesis could be due to differences between the population variances rather than the population means (Kachigan, 1986).

Hair et al. (1995) noted that the logic of an ANOVA test is straightforward. During ANOVA testing two independent estimates of the variance for the dependent variable are compared. One of these estimates is sensitive to treatment effects while the second estimate is not. In essence, the ANOVA results are a measure of how much variance is attributable to the different treatments versus the variance expected from random sampling (Hair et al., 1995).

This ANOVA technique has been used in similar prior research such as that conducted by Bouchard and Hare (1970), Gallupe and DeSanctis (1988), Gallupe et al. (1992), and Kelly and Karau (1993).

Since this dissertation investigated multiple dependent variables, it is appropriate to investigate the relationship between all the dependent variables operating together. In similar research, the multivariate analysis of variance (MANOVA) has been utilized to investigate the relationship between such multiple variables (Zigurs et al., 1988; and Alavi, 1994).

Tabachnick and Fidell (1989) noted several research conditions where MANOVA would be a useful technique. These conditions included the following: (a) situations where all, or at least some independent variables are manipulated, (b) subjects are randomly assigned to groups, and (c) groups have equal sizes. This dissertation conforms to these requirements as noted in prior sections. Therefore, this statistical technique was also utilized in this dissertation.

The Multivariate Analysis of Variance (MANOVA) Technique

In this particular research, there is interest in more than one dependent variable, specifically as a result of the differing time treatments. By utilizing this additional technique it may be possible to uncover additional interactions among the various dependent variables. As previously noted, this technique has been used in prior similar research such as that conducted by Jarvenpaa and Srinivasan Rao (1988), Zigurs et al. (1988), and Alavi (1994).

Hair et al. (1995) noted that while analysis of variance may be represented as H_0: $\mu_1 = \mu_2 = \mu_3 \ldots \mu_k$, the multivariate analysis of variance null hypothesis to be tested could best be represented in the following form:

$$H_0 : \begin{matrix} \mu_{11} \\ \mu_{21} \\ \mu_{31} \\ \mu_{p1} \end{matrix} = \begin{matrix} \mu_{12} \\ \mu_{22} \\ \mu_{32} \\ \mu_{p2} \end{matrix} = \begin{matrix} \mu_{1k} \\ \mu_{2k} \\ \mu_{3k} \\ \mu_{pk} \end{matrix}$$

Figure 1. MANOVA null hypothesis model.

According to Hair et al. (1995), μ_{pk} is equal to the mean of variable p, while the time period is represented by k. While considering the MANOVA tests conducted in this dissertation, there are four dependent variables operating within three different groups. Within each group are three time periods. For each MANOVA test the dependent variables associated with each of these three differing time periods are contained within the three vectors depicted in Figure 1. Each time period is represented by one of the three vectors noted in Figure 1.

In this dissertation, three MANOVA tests were conducted. The first test was conducted on the 3, 6, 9 minute group. Therefore, all four dependent variables associated with the 3 minute time period for the first group would be contained in the vector represented by μ_{11} ... μ_{p1}. All dependent variables associated with the 6 minute time period for the first group would be contained in the vector μ_{12} ... μ_{p2}. Finally, all dependent variables associated with the 9 minute time period for the first group would be contained in the vector $\mu_{1k} \ldots \mu_{pk}$.

The second MANOVA test was conducted on the 6, 6, 6 minute group. The third and final MANOVA test was conducted on the 9, 6, 3 minute group.

In MANOVA, the null hypothesis tested is the equality of vectors of means on multiple dependent variables across groups. Hair et al. (1995) defined a vector as a set of real numbers (e.g., $X_1 \ldots X_n$). Column vectors as shown in Figure 1 are considered conventional. The unique aspect of MANOVA is that the variate or vector (linear combination of variables) combines the multiple dependent measures into a single value that maximizes the differences across groups (Hair et al., 1995).

The distinction between the hypotheses tested in ANOVA and MANOVA is that in ANOVA, a single dependent measure is tested for equality across groups. In MANOVA testing, a variate is tested for equality (Hair et al., 1995).

Hypotheses

The hypotheses that follow are based upon the relationship between the independent variable, time, and the dependent variables previously noted.

The null and alternative hypotheses are stated as follows:

H_{01}: The mean rate of idea generation is equal in groups operating under differing time constraints.

H_{A1}: The mean rate of idea generation is unequal in groups operating under differing time constraints.

H_{02}: The mean rate of the creativity of ideas is equal in groups operating under differing time constraints.

H_{A2}: The mean rate of the creativity of ideas is unequal in groups operating under differing time constraints.

H_{03}: The mean rate of the number of hierarchical idea categories produced is equal in groups operating under differing time constraints.

H_{A3}: The mean rate of the number of hierarchical idea categories produced is unequal in groups operating under differing time constraints.

H_{04}: The mean rate of the number of ideas chained is equal in groups operating under differing time constraints.

H_{A4}: The mean rate of the number of ideas chained is unequal in groups operating under differing time constraints.

H_{05}: The mean rate of: (a) idea generation, (b) creativity of ideas, (c) hierarchical idea categories, and (d) ideas chained is equal in groups operating under differing time constraints.

H_{A5}: The mean rate of: (a) idea generation, (b) creativity of ideas, (c) hierarchical idea categories, and (d) ideas chained is unequal in groups operating under differing time constraints.

Fixed and Random Effects

The model for this dissertation consist of two fixed effects and one random effect. The fixed effects consist of both the group and the 30 second interval period. During the experiments, participants were randomly assigned to three person, same-sex groups. Although the participants were randomly assigned to groups, all groups consisted of three participants. This remained the same for each treatment.

It is important to also note that although the time periods for each group were randomized, it was the 30 second intervals that were measured. Therefore, since the interval used in the measurement remains constant at 30 seconds, it was treated as a fixed effect.

One random effect was also part of the model. This random effect was task. As noted previously, one of three possible tasks were randomly assigned to each group for each of their time periods. For example, one group operating under the 3, 6, and 9 time period constraint may be given the shoelace task for the three minute period, the paper clip task for the 6 minute period, and the cup task for the 9 minute period. Another group operating under the same 3, 6, and 9 minute time constraint may be given the cup for the 3 minute period, the shoelace for the 6 minute period, and the paper clip for the 9 minute period. Figure 20 provides a graphical representation of this model.

Pre-Testing

The experiment previously described was pre-tested using 27 undergraduate business school students from Palm Beach Atlantic College. The pre-testing was conducted in the GSS laboratory at Nova Southeastern University.

The data from the post-trial questionnaire for all groups operating under the three time periods was examined. The data indicate that the 3 minute groups felt more rushed with their task than did the 6 minute groups who, in turn, felt more rushed than the 9 minute groups. This provided support to the selection of the specific three time intervals that were utilized during the testing.

CHAPTER IV

ANALYSIS AND PRESENTATION OF FINDINGS

Introduction

This chapter presents and discusses the statistical findings as a result of the completed study. Included in this chapter are the following: (a) ANOVA results from each of four dependent variables, (b) MANOVA results, (c) inter-rater reliability statistics, (d) tables and figures summarizing the data gathered from the study, and (e) prior research supported by this study.

Prior research investigated the relationship of time pressure and idea generation (Frye & Stritch, 1964; Wright, 1974; Bowden, 1985; Zakay & Woller, 1984; Kelly, Futoran, & McGrath, 1990; Kelly & Karau, 1993). This study continued this research and applied it to Steiner's (1972) theory of productivity.

This study investigated the impact of time pressure on four dependent variables: (a) the mean rate of generated ideas, (b) the mean creativity rating of ideas, (c) the mean rate of idea categories generated, and (d) the mean rate of idea chaining. This study particularly carried forward the work of Kelly and Karau (1993) as well as a variety of researchers who contributed to group support systems literature (Aronson et al., 1987; Diehl & Stroebe, 1987; Connolly et al., 1990; Dennis et al., 1995).

The first null hypothesis focused on the mean rate of ideas generated from groups operating under differing time constraints. The second null hypothesis examined the mean rate of creativity among the ideas generated by the groups. The third hypothesis targeted the mean rate of idea categories generated by the groups. The fourth hypothesis was concerned with the mean rate of chained ideas within the groups. The fifth and final hypothesis investigated the mean rate of: (a) idea generation, (b) creativity of ideas, (c) hierarchical idea categories, and (d) ideas chained. A multivariate analysis of variance examined the relationship of these dependent variables.

Three differing treatments were used throughout this study. These three treatments consisted of three groups operating under one of three time constraints. One group operated under a 3, 6, and 9 minute condition. The second group operated under a 6, 6, and 6 minute condition. The third group operated under a 9, 6, and 3 minute condition.

Throughout this research a group support system was used to gather the data. This networked computer system accurately documented all ideas submitted from the 34 groups used in the study. The state-of-the-art group support system laboratory at Nova Southeastern University was used for this study.

Two statistical techniques were used to test the four hypotheses in this study. The techniques used were the analysis of variance (ANOVA) and the multivariate analysis of variance (MANOVA). Both statistical techniques were appropriate for a study of this type. Prior similar research has utilized both of these statistical techniques (Bouchard & Hare, 1970; Gallupe & DeSanctis, 1988; Gallupe et al., 1992; and Kelly & Karau, 1993).

This chapter documents and discusses the results of the statistical techniques used to test the hypotheses presented in this study.

Null Hypothesis One: Analysis and Discussion

This hypothesis stated that the mean rate of idea generation is equal in groups operating under differing time constraints. The analytical technique used to test this hypothesis was a one way analysis of variance (ANOVA). A significance level of 0.05 was selected. The statistical results from this test are found in Tables 1 through 6.

The following information may be referenced for tables used throughout this dissertation:

N = Total number of samples

DF = Degrees of freedom

SS = Sum of squares

MS = Mean square

StDev = Standard deviation

F = Computed F ratio

P = If P value is $<.05$, reject H_0. If P value is $\geq .05$, fail to reject H_0.

Tables 1 and 2 depict summary results of idea generation information and ANOVA results for the groups operating under the 3, 6, and 9 minute conditions.

Table 1

Group Means for Idea Rate (3, 6, 9 Group)

Group	N	Mean	StDev
3 minute	72	3.78	1.83
6 minute	144	3.63	1.57
9 minute	216	3.55	1.58

Table 2

ANOVA for Idea Rate (3, 6, 9 Group)

Source	DF	SS	MS	F	P
Factor	2	4.29	2.14	0.82	0.442
Error	429	1126.19	2.63		
Total	431	1130.48			

In this 3, 6, and 9 minute test the degrees of freedom are 2 and 429. There are 2 degrees of freedom for the numerator and 429 degrees of freedom in the denominator. The two degrees of freedom (2, 429), are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator total 429, found by N - k, where N is the total number of samples (Mason & Lind, 1993). There were 432 samples in this test, therefore, 432 - 3 = 429.

Based upon the degrees of freedom (2, 429), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of

equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 1, the F value for the 3, 6, and 9 minute group is 0.82. Since this value is less than the 3.07 critical F value, the null hypothesis fails to be rejected for the 3, 6, and 9 minute group.

Figure 2 graphically depicts the mean rate of ideas for the 3, 6, and 9 minute groups. It is interesting to note that a decrease in the mean rate occurs for all three groups during the second 30 second interval. Additionally, all three groups experienced an increase in the mean rate of ideas during the last 30 second interval.

Although the literature remains silent regarding this last 30 second interval increase, speculation regarding the cause is appropriate. During the actual experiment, all groups were notified every 30 seconds by the facilitator how much time remained in the experiment as noted by Wright (1974). Having this knowledge allowed the participants to know when their final 30 second period was about to occur. Therefore, it appears that as groups were reaching the end of their allotted time, they increased their mean rate of ideas.

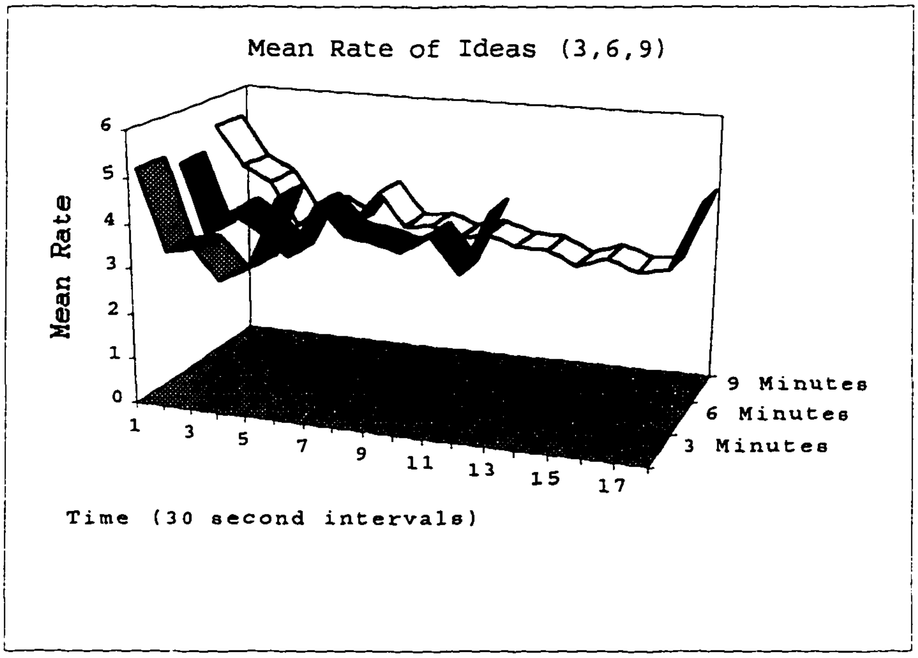

Figure 2. Mean rate of ideas (3, 6, 9 group).

Tables 3 and 4 depict summary results of idea generation information and ANOVA results for the groups operating under the 6, 6, and 6 minute conditions.

Table 3

Group Means for Idea Rate (6, 6, and 6 Group)

Group	N	Mean	StDev
6 minutes	120	3.66	1.49
6 minutes	120	4.23	1.78
6 minutes	120	4.38	2.11

Table 4

ANOVA for Idea Rate (6, 6, 6 Group)

Source	DF	SS	MS	F	P
Factor	2	34.87	17.44	5.33	0.005
Error	357	1168.28	3.27		
Total	359	1203.16			

In this 6, 6, and 6 minute test the degrees of freedom are 2 and 357. There are 2 degrees of freedom for the numerator and 357 degrees of freedom in the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator are found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 360 samples in this test, therefore, 360 - 3 = 357.

Based upon the degrees of freedom (2, 429), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of

equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 3, the F value for the 6, 6, and 6 minute group is 5.33. Since this value is greater than the 3.07 critical F value, the null hypothesis must be rejected for the 6, 6, and 6 minute group.

Figure 3 graphically depicts the mean rate of ideas for the 6, 6, and 6 minute groups. It can be seen that a decrease in the mean rate occurs for all three groups during the initial periods of the testing. Additionally, all three groups experienced an increase in the mean rate of ideas during the last 30 second interval.

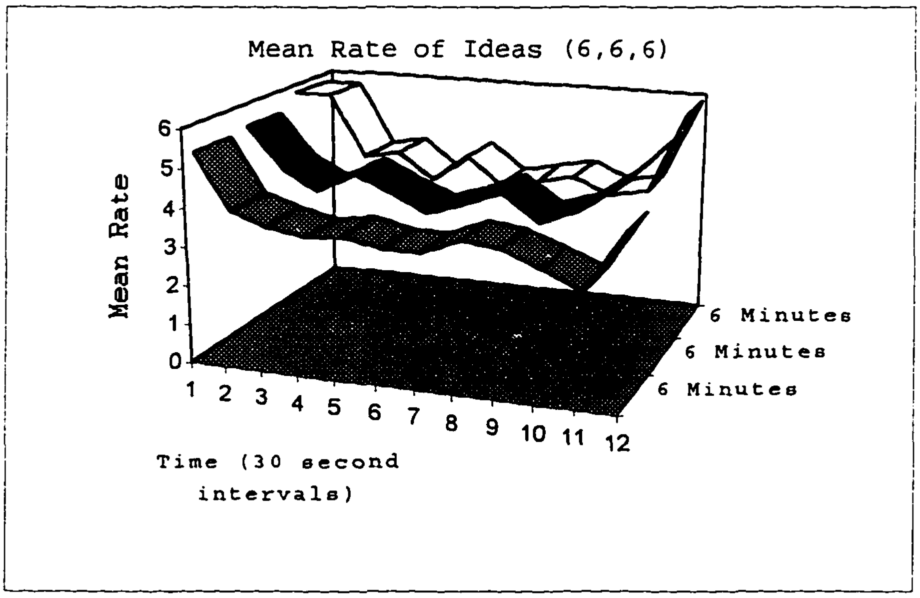

Figure 3. Mean rate of ideas (6, 6, 6, group).

Tables 5 and 6 depict summary results of idea generation information and ANOVA results for the groups operating under the 9, 6, and 3 minute conditions.

Table 5

Group Means for Idea Rate (9, 6, and 3 Group)

Group	N	Mean	StDev
9 minute	216	2.57	1.30
6 minute	144	3.08	1.42
3 minute	72	4.29	1.85

Table 6

ANOVA for Idea Rate (9, 6, 3 Group)

Source	DF	SS	MS	F	P
Factor	2	161.75	80.88	38.94	0.000
Error	429	890.97	2.08		
Total	431	1052.72			

In this 9, 6, and 3 minute test the degrees of freedom are 2 and 429. There are 2 degrees of freedom for the numerator and 429 for the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore

k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator are found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 432 samples in this test, therefore, 432 - 3 = 429.

Based upon the degrees of freedom (2, 429), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 5, the F value for the 9, 6, and 3 minute group is 38.94. Since this value is greater than the 3.07 critical F value, the null hypothesis must be rejected for the 9, 6, and 3 minute group.

Figure 4 graphically depicts the mean rate of ideas for the 3, 6, and 9 minute groups. Again, it is evident that there is a decrease in the mean rate during the initial intervals followed by an increase in mean rate in the closing intervals of the experiment.

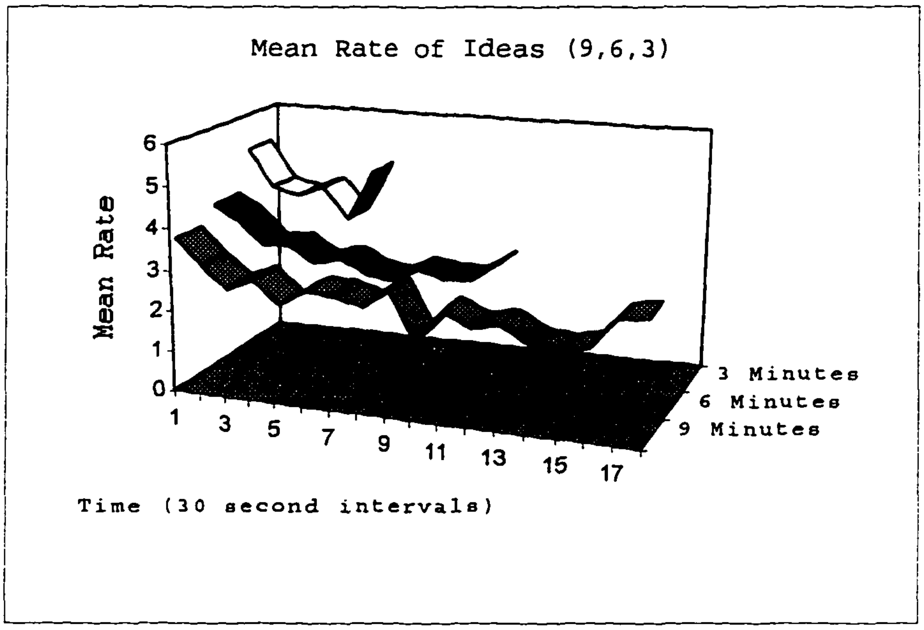

Figure 4. Mean rate of ideas (9, 6, 3 group).

Based upon the ANOVA tests completed utilizing the dependent variable of the mean rate of ideas, null hypothesis one must be rejected in favor of the alternative hypothesis which states that the mean rate of idea generation is unequal in groups operating under differing time constraints.

It is interesting to note that for groups operating under the 3, 6, and 9 minute time constraint the mean values for idea rate support the concept of entrainment as noted by Kelly and Karau (1993). Based upon data from the 9, 6, and 3 minute groups, it is evident the as time pressure increased the mean values also increased.

Null Hypothesis Two: Analysis and Discussion

This hypothesis stated that the mean rate of the creativity of ideas is equal among groups operating under differing time constraints. The analytical technique used to test this hypothesis was also a one way analysis of variance (ANOVA). A significance level of 0.05 was selected. The ANOVA results of this test are found in Tables 7 through 12.

As noted in prior research (Zigurs et al., 1988; Kelly & Karau, 1993; Dennis & Valacich, 1994), independent raters were used to review the transcript of generated ideas and rate each idea on a 1 to 5 scale. Raters were provided with an overview of the rating scale as noted by Hackman et al. (1967). The raters then practiced using pre-test data (Gallupe et al., 1991).

After rating the non-redundant ideas of the 34 groups used in this study, the inter-rater reliability was calculated. The inter-rater reliability for the two raters used in this research was 97.71% (Gallupe et al., 1992). This reliability was consistent with prior research (Connolly et al., 1990; Gallupe et al., 1991; and Gallupe et al., 1992).

Tables 7 and 8 depict summary creativity ratings and ANOVA results for the groups operating under the 3, 6, and 9 minute conditions.

Table 7

Group Means for Idea Creativity (3, 6, 9 Group)

Group	N	Mean	StDev
3 minute	72	1.21	0.28
6 minute	144	1.19	0.31
9 minute	216	1.20	0.28

Table 8

ANOVA for Idea Creativity (3, 6, 9 Group)

Source	DF	SS	MS	F	P
Factor	2	0.03	0.02	0.19	0.827
Error	429	37.12	0.09		
Total	431	37.15			

In this 3, 6, and 9 minute test the degrees of freedom are 2 and 429. There are 2 degrees of freedom for the numerator and 429 for the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore

k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator are found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 432 samples in this test, therefore, 432 - 3 = 429.

Based upon the degrees of freedom (2, 429), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 7, the F value for the 3, 6, and 9 minute group is 0.19. Since this value is less than the 3.07 critical F value, the null hypothesis fails to be rejected for the 3, 6, and minute group.

Figure 5 graphically depicts the mean creativity of ideas for the 3, 6, and 9 minute groups.

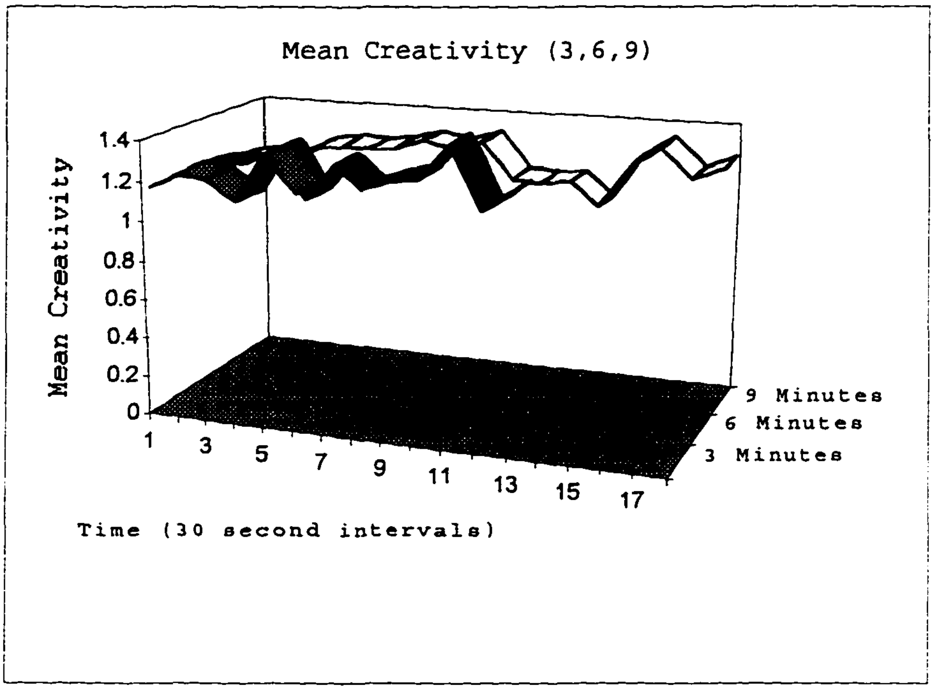

Figure 5. Mean creativity (3, 6, 9, group).

Tables 9 and 10 depict summary creativity rating information and ANOVA results for the groups operating under the 6, 6, and 6 minute conditions.

Table 9

Group Means for Idea Creativity (6, 6, and 6 Group)

Group	N	Mean	StDev
6 minute	120	1.29	0.32
6 minute	120	1.20	0.24
6 minute	120	1.21	0.21

Table 10

ANOVA for Idea Creativity (6, 6, 6 Group)

Source	DF	SS	MS	F	P
Factor	2	0.55	0.28	4.04	0.018
Error	357	24.45	0.07		
Total	359	25.00			

In this 6, 6, and 6 minute test the degrees of freedom are 2 and 357. There are 2 degrees of freedom in the numerator and 357 in the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator are found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 360 samples in this test, therefore, 360 - 3 = 357.

Based upon the degrees of freedom (2, 357), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of

equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 9, the F value for the 6, 6, and 6 minute group is 4.04. Since this value is greater than the 3.07 critical F value, the null hypothesis must be rejected for the 6, 6, and 6 minute group.

Figure 6 graphically depicts the mean rate of creativity for the 6, 6, and 6 minute groups.

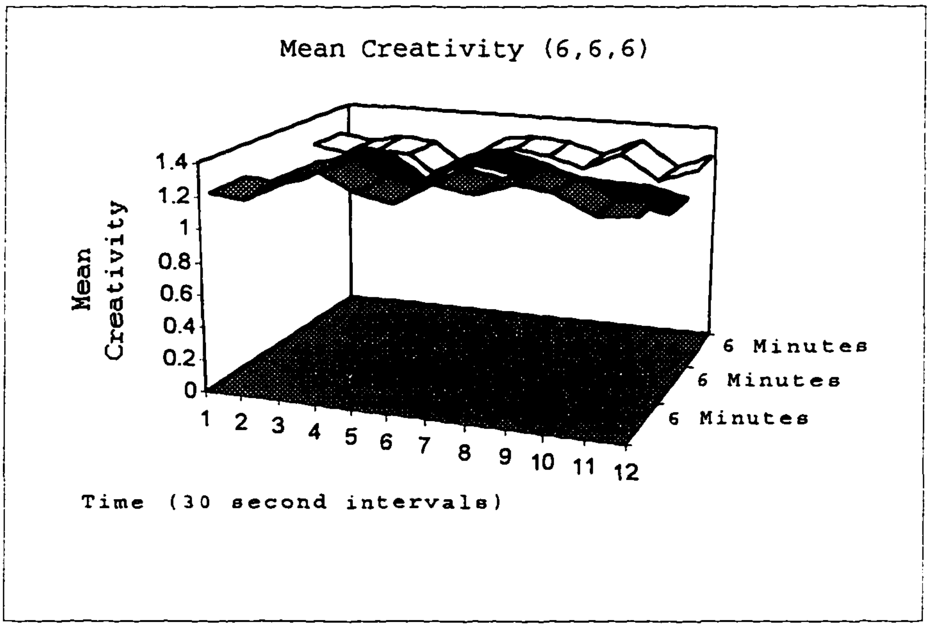

Figure 6. Mean creativity (6, 6, 6 group).

Tables 11 and 12 depict summary creativity rating information and ANOVA results for groups operating under the 9, 6, and 3 minute conditions.

Table 11

Group Means for Idea Creativity (9, 6, and 3 Group)

Group	N	Mean	StDev
9 minute	216	1.17	0.34
6 minute	144	1.20	0.31
3 minute	72	1.17	0.18

Table 12

ANOVA for Idea Creativity (9, 6, 3 Group)

Source	DF	SS	MS	F	P
Factor	2	0.10	0.05	0.52	0.594
Error	429	40.13	0.09		
Total	431	40.23			

In this 9, 6, and 3 minute test the degrees of freedom are 2 and 429. There are 2 degrees of freedom for the numerator and 429 for the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore

k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator are found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 432 samples in this test, therefore, 432 - 3 = 429.

Based upon the degrees of freedom (2, 429), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 11, the F value for the 9, 6, and 3 minute group is 0.52. Since this value is less than the 3.07 critical F value, the null hypothesis fails to be rejected for the 9, 6, and 3 minute group. To further support this, the P value for this group is 0.594.

Figure 7 graphically depicts the mean creativity for the 9, 6, and 3 minute groups.

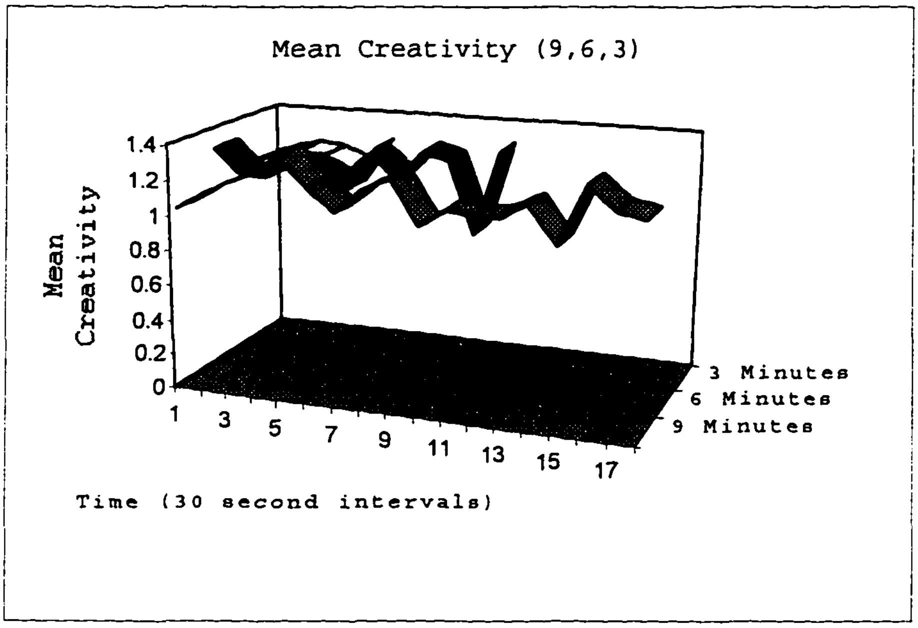

Figure 7. Mean creativity (9, 6, 3 group).

Based upon the ANOVA tests completed utilizing the dependent variable of mean rate of idea creativity, null hypothesis two must be rejected in favor of the alternative hypothesis which states that the mean rate of the creativity of ideas is unequal among groups operating under differing time constraints.

One area of interest is the low mean values generated for the creativity of ideas. Prior research in a similar study noted similar creativity means (Kelly & Karau, 1993). Based upon the mean values for creativity generated by this study, there is support for the claim by Kelly and Karau (1993) that time pressure generates a faster mean rate of ideas but generates ideas of lower creativity than those generated by groups not placed under time pressure.

Null Hypothesis Three: Analysis and Discussion

This hypothesis stated that the mean rate of the number of hierarchical idea categories produced is equal in groups operating under differing time constraints. The analytical technique used to test this hypothesis was also a one way analysis of variance (ANOVA). A significance level of 0.05 was selected. The statistical results from these tests are found in Tables 13 through 18.

Following the work of Connolly et al. (1990), two independent raters, blind to the hypotheses, developed 14 hierarchical categories for each idea generated by the 34 groups in this study. These categories are found in Appendix I. Each of the non-redundant ideas was placed into one of the 14 categories.

Tables 13 and 14 depict summary category information and ANOVA results for the groups operating under the 3, 6, and 9 minute conditions.

Table 13

Group Means for Idea Categories (3, 6, 9 Group)

Group	N	Mean	StDev
3 minute	72	2.49	1.10
6 minute	144	2.31	1.03
9 minute	216	2.38	0.97

Table 14

ANOVA for Idea Categories (3, 6, 9 Group)

Source	DF	SS	MS	F	P
Factor	2	1.45	0.72	0.71	0.494
Error	429	439.55	1.02		
Total	431	441.00			

In this 3, 6, and 9 minute test the degrees of freedom are 2 and 429. There are 2 degrees of freedom for the numerator and 429 for the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator are found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 432 samples in this test, therefore, 432 - 3 = 429.

Based upon the degrees of freedom (2, 429), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 13, the F value for the 3, 6, and 9 minute group is 0.71. Since this value is less than the 3.07 critical F value, the null hypothesis fails to be rejected for the 3, 6, and 9 minute group.

Figure 8 graphically depicts the mean rate of categories for the 3, 6, and 9 minute groups. This graph clearly shows a drop in the mean rate of categories generated during the second 30 second interval. This is followed by an increase in the mean rate during the final 30 second intervals in the experiments.

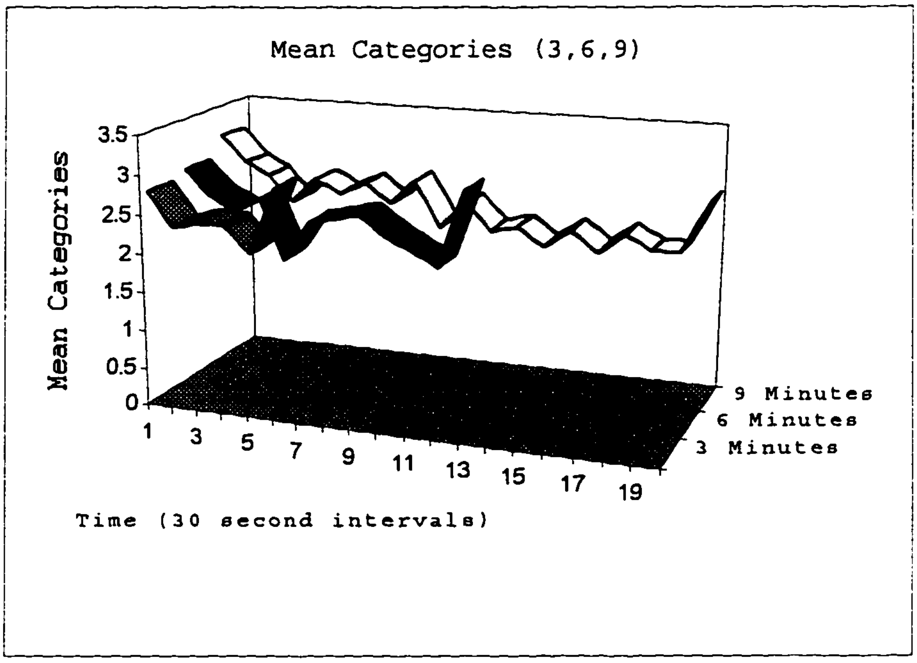

Figure 8. Mean categories (3, 6, 9 group).

Tables 15 and 16 depict summary information for categories generated and ANOVA results for the groups operating under the 6, 6, and 6 minute conditions.

Table 15

Group Means for Idea Categories (6, 6, 6 Group)

Group	N	Mean	StDev
6 minute	120	2.52	1.12
6 minute	120	2.73	1.15
6 minute	120	2.70	1.14

Table 16

ANOVA for Idea Categories (6, 6, 6 Group)

Source	DF	SS	MS	F	P
Factor	2	3.11	1.55	1.21	0.300
Error	357	459.09	1.29		
Total	359	462.20			

In this 6, 6, and 6 minute test the degrees of freedom are 2 and 357. There are 2 degrees of freedom for the numerator and 357 for the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator are found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 360 samples in this test, therefore, 360 - 3 = 357.

Based upon the degrees of freedom (2, 357), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of

equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 15, the F value for the 6, 6, and 6 minute group is 1.21. Since this value is less than the 3.07 critical F value, the null hypothesis fails to be rejected for the 6, 6, and 6 minute group.

Figure 9 graphically depicts the mean category data for the 6, 6, and 6 minute group. Again, the graph shows a decrease in the mean rate of categories during the second 30 second interval. This is followed by an increase in the mean rate during the final periods.

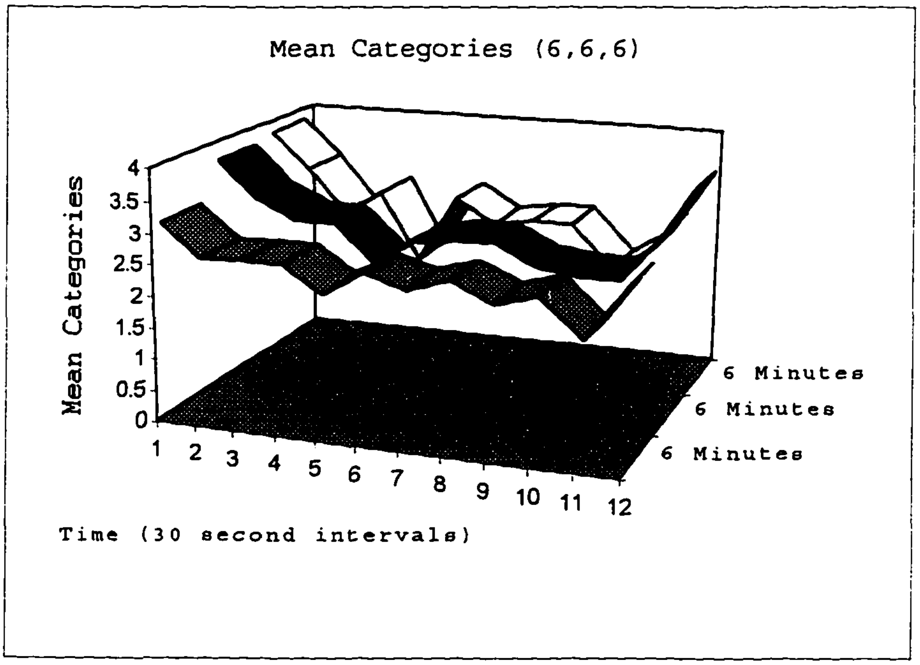

Figure 9. Mean categories (6, 6, 6 group).

Tables 17 and 18 depict summary category rates and ANOVA results for the groups operating under the 9, 6, and 3 minute conditions.

Table 17

Group Means for Idea Categories (9, 6, 3 Group)

Group	N	Mean	StDev
9 minute	216	1.92	0.94
6 minute	144	2.29	1.03
3 minute	72	2.64	1.22

Table 18

ANOVA for Idea Categories (9, 6, 3 Group)

Source	DF	SS	MS	F	P
Factor	2	31.06	15.53	14.95	0.000
Error	429	445.60	1.04		
Total	431	476.66			

In this 9, 6, and 3 minute test the degrees of freedom are 2 and 429. There are 2 degrees of freedom for the numerator and 429 for the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore

k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator can be found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 432 samples in this test, therefore, 432 - 3 = 429.

Based upon the degrees of freedom (2, 429), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 17, the F value for the 9, 6, and 3 minute group is 14.95. Since this value is greater than the 3.07 critical F value, the null hypothesis must be rejected for the 9, 6, and 3 minute group.

Figure 10 graphically depicts the mean category data for the 9, 6, and 3 minute groups.

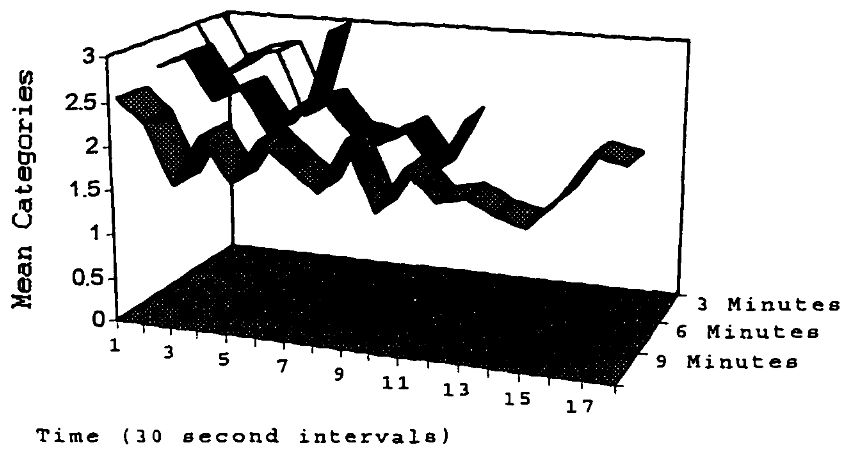

Figure 10. Mean categories (9, 6, 3 group).

Based upon the ANOVA tests completed utilizing the dependent variable of the mean rate of the number of idea categories, null hypothesis three must be rejected in favor of the alternative hypothesis which states that the mean rate of the number of hierarchical idea categories produced is unequal in groups operating under differing time constraints.

The mean values for the 3, 6, and 9 minute groups again give support to the concept of entrainment as noted by Kelly and Karau (1993). It is also interesting to note that again the groups operating under the 9, 6, and 3 minute condition increased the mean values for categories generated as time pressure increased.

Null Hypothesis Four: Analysis and Discussion

This hypothesis stated that the mean rate of the number of ideas chained is equal among groups operating under differing time constraints. The analytical technique used to test this hypothesis was also a one way analysis of variance (ANOVA). A significance level of 0.05 was selected. The statistical results of this test are found in Tables 19 through 24.

Following the work of Connolly et al. (1990), independent raters, blind to the hypotheses, followed the coding scheme found in Appendix H. Ideas coded as supportive argument (SA) or solution clarification (SCL) were classified as chained ideas since by definition both of these categories fulfill Osborn's (1957) definition of chaining. Prior to the actual coding of ideas, raters practiced using pre-test data (Gallupe et al., 1991).

After completing the coding of all non-redundant ideas generated by the 34 groups, the inter-rater reliability was calculated. The inter-rater reliability was 99.63%. This reliability was also consistent with prior research

(Connolly et al., 1990; Gallupe et al., 1991; and Gallupe et al., 1992).

Tables 19 and 20 depict summary rate of idea chaining information and ANOVA results for the groups operating under the 3, 6, and 9 minute conditions.

Table 19

Group Means for Idea Chaining (3, 6, 9 Group)

Group	N	Mean	StDev
3 minute	72	0.51	0.89
6 minute	144	0.49	0.78
9 minute	216	0.54	0.86

Table 20

ANOVA for Idea Chaining (3, 6, 9 Group)

Source	DF	SS	MS	F	P
Factor	2	0.17	0.08	0.12	0.888
Error	429	303.68	0.71		
Total	431	303.85			

In this 3, 6, and 9 minute test the degrees of freedom are 2 and 429. There are 2 degrees of freedom for the numerator and 429 for the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator can be found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 432 samples in this test, therefore, 432 - 3 = 429.

Based upon the degrees of freedom (2, 429), and. a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 19, the F value for the 3, 6, and 9 minute group is 0.12. Since this value is less than the 3.07 critical F value, the null hypothesis fails to be rejected for the 3, 6, and 9 minute group.

Figure 11 graphically depicts the mean rate of idea chaining for the 3, 6, and 9 minute groups. This graph shows a decrease in the mean rate during the initial 30 second intervals.

Although the literature remains silent on this issue, it is possible that during the initial 30 second intervals group participants watched the ideas submitted by other group members. After observing the types of responses, all participants shifted their focus from observing to participating in the process, thereby resulting in the initial decrease.

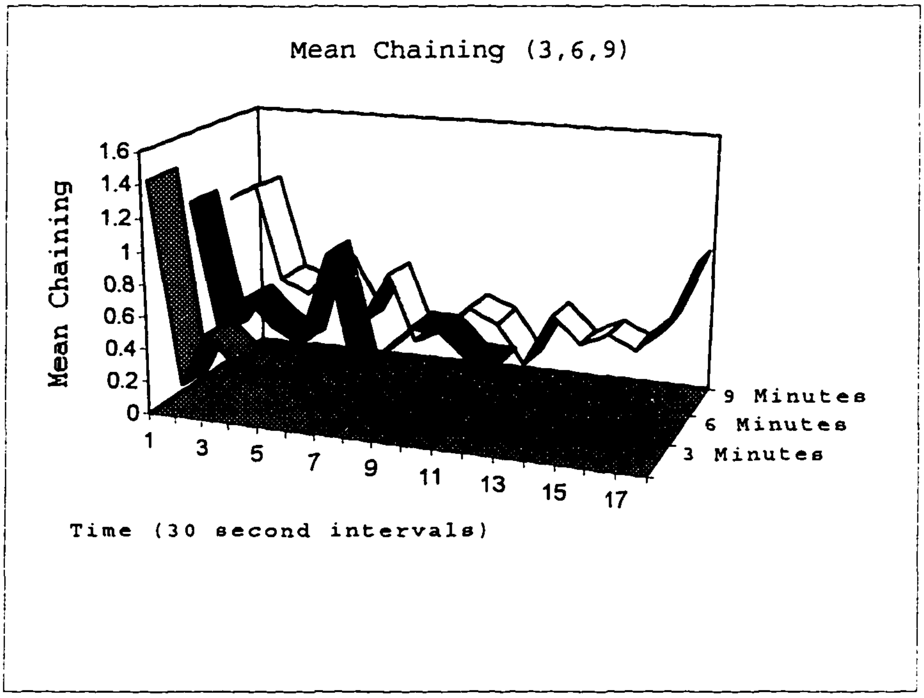

Figure 11. Mean chaining (3, 6, 9 group).

Tables 21 and 22 depict summary rate of idea chaining information and ANOVA results for the groups operating under the 6, 6, and 6 minute condition.

Table 21

Group Means for Idea Chaining (6, 6, and 6 Group)

Group	N	Mean	StDev
6 minute	120	0.46	0.68
6 minute	120	0.50	0.69
6 minute	120	0.59	0.92

Table 22

ANOVA for Idea Chaining (6, 6, 6 Group)

Source	DF	SS	MS	F	P
Factor	2	1.12	0.56	0.94	0.393
Error	357	212.78	0.60		
Total	359	213.90			

In this 6, 6, and 6 minute test the degrees of freedom are 2 and 357. There are 2 degrees of freedom for the numerator and 357 in the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore k - 1 is equal to 3 - 1 = 2. The degrees of freedom in the denominator can be found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 360 samples in this test, therefore, 360 - 3 = 357.

Based upon the degrees of freedom (2, 357), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 21, the F value for the 6, 6, and 6 minute group is 0.94. Since this value is less than the 3.07 critical F value, the null hypothesis fails to be rejected for the 6, 6, and 6 minute group.

Figure 12 graphically depicts the mean rate of chaining data for the 6, 6, and 6 minute groups. Again, the graph shows a decrease in the mean rate of idea chaining during the initial intervals similar to the 3, 6, and 9 minute group.

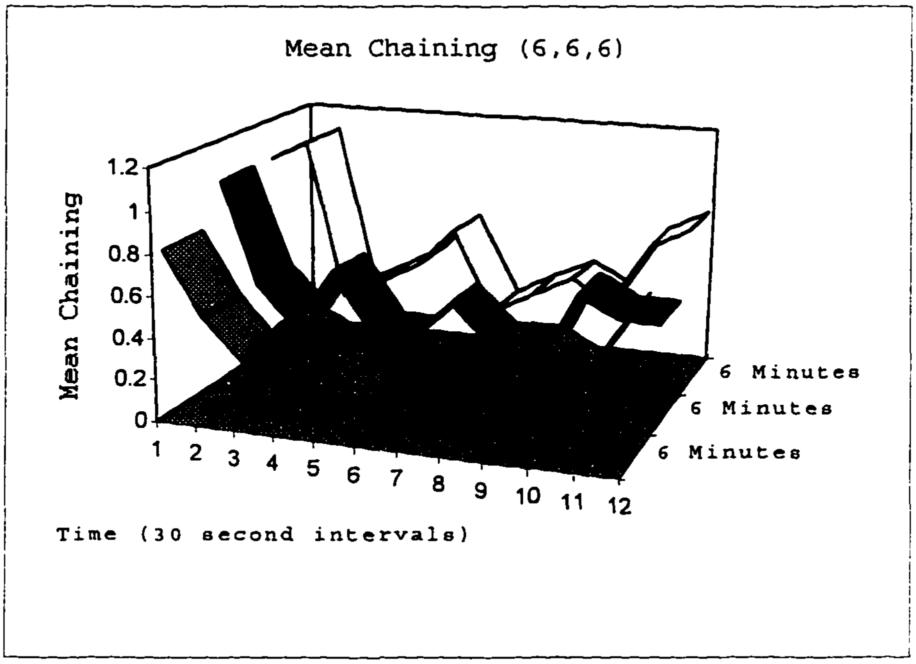

Figure 12. Mean chaining (6, 6, 6 group).

Tables 23 and 24 depict summary rate of idea chaining information and ANOVA results for the groups operating under the 9, 6, and 3 minute conditions.

Table 23

Mean Rate for Idea Chaining (9, 6, 3 Group)

Group	N	Mean	StDev
9 minute	216	0.25	0.53
6 minute	144	0.32	0.56
3 minute	72	0.64	0.79

Table 24

ANOVA for Idea Chaining (9, 6, 3 Group)

Source	DF	SS	MS	F	P
Factor	2	8.24	4.12	11.75	0.000
Error	429	150.42	0.35		
Total	431	158.66			

In this 9, 6, and 3 minute test the degrees of freedom are 2 and 429. There are 2 degrees of freedom for the numerator and 429 in the denominator. The two degrees of freedom are derived from k - 1, where k is the number of treatments (groups). There are three groups, therefore k - 1 is equal to 3 - 1 = 2. The degrees of freedom can be found by utilizing the formula N - k, where N is the total number of samples (Mason & Lind, 1993). There were 432 samples in this test, therefore, 432 - 3 = 429.

Based upon the degrees of freedom (2, 429), and a significance level of 0.05, the decision rule can be obtained. The critical F value in this case is again 3.07. Therefore, any F ratio less than or equal to 3.07 would result in a failure to reject the null hypothesis. Any F ratio greater than 3.07 would cause the null hypothesis of equality to be rejected in favor of the alternative hypothesis of inequality.

As depicted in Table 23, the F value for the 9, 6, and 3 minute group is 11.75. Since this value is greater than the 3.07 critical F value, the null hypothesis must be rejected for the 9, 6, and 3 minute group.

Figure 13 graphically depicts the mean rate of idea chaining for the 9, 6, and 3 minute groups. Again, the initial 30 second intervals show a decrease in the mean rate of idea chaining similar to both the 3, 6, and 9 minute group as well as the 6, 6, and 6 minute group.

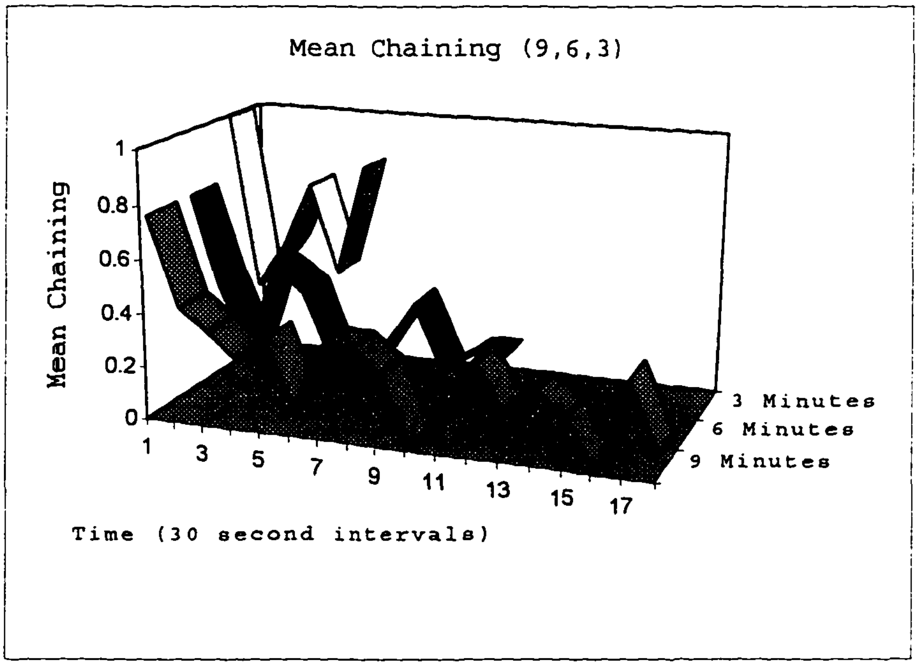

Figure 13. Mean chaining (9, 6, 3 group).

Based upon the ANOVA tests completed utilizing the dependent variable of mean rate of chained ideas, null hypothesis four must be rejected in favor of the alternative hypothesis which states that the mean rate of ideas chained is unequal in groups operating under differing time constraints.

Again the mean values associated with the 3, 6, and 9 minute groups lend support to the entrainment concept noted by Kelly and Karau (1993). Additionally, the groups operating under the 9, 6, and 3 minute time constraint increased their mean values for idea chaining as time pressure was increased.

Null Hypothesis Five: Analysis and Discussion

The use of the multivariate analysis of variance (MANOVA) technique is appropriate for this study since there is interest in more than one dependent variable, specifically as a result of differing time treatments. This technique has been used in prior similar research (Jarvenpaa and Srinivasan Rao, 1988; Zigurs et al., 1988; and Alavi, 1994). In the MANOVA, a variate is tested for equality rather than a single dependent measure as in ANOVA (Hair et al., 1995).

MANOVA presents several criteria to assess multivariate differences across groups. Three of the most commonly used are Wilk's lambda, the Lawley-Hotelling test, and Pillai's test.

Wilk's lambda examines whether groups are different without being concerned with whether they differ on at least one linear combination of the dependent variables. The Lawley-Hotelling test is also a primary test associated with MANOVA. The computational formula represents the results of mathematical derivations used to solve for a maximum t statistic.

The premise of this test is that if a discriminant function can be found between groups that produces a significant T^2, the two groups are considered different across the mean vectors (Hair et al., 1995). Pillai's test is yet another method used to assess the differences across "dimensions" of the dependent variables (Hair et al., 1995, p. 277).

Researchers do not have a definitive preference among these three statistical tests. Therefore, all three tests are generally provided as a portion of the MANOVA statistical test (Hair et al., 1995).

Table 25 contains MANOVA results for the 3, 6, and 9 minute group.

Table 25

MANOVA for the 3, 6, 9 Group

Criterion	Test Statistic	F	DF	P
Wilk's	0.99	0.76	(8, 852)	0.64
Lawley-Hotelling	0.01	0.76	(8, 850)	0.64
Pillai's	0.01	0.76	(8, 854)	0.64

Utilizing degrees of freedom of either (8, 852), (8, 850), (8, 854), and a significance level of 0.05, the decision rule can be obtained. The critical F for all three tests noted in Table 25 is 2.02. Therefore, since the calculated F for all three tests is less than the critical F, the null hypothesis of equality fails to be rejected.

Table 26 contains the MANOVA results for the 6, 6, and 6 minute group.

Table 26

MANOVA for the 6, 6, 6 Group

Criterion	Test Statistic	F	DF	P
Wilk's	0.95	2.37	(8, 708)	0.016
Lawley-Hotelling	0.05	2.39	(8, 706)	0.015
Pillai's	0.05	2.36	(8, 710)	0.017

Utilizing degrees of freedom of either (8, 708), (8, 706), (8, 710), and a significance level of 0.05, the decision rule can be obtained. The critical F for all three tests noted in Table 26 is 2.02. Therefore, since the calculated F for all three tests is greater than the critical F, the null hypothesis of equality must be rejected in favor of the alternative hypothesis of inequality.

Table 27 contains the MANOVA results for the 9, 6, and 3 minute group.

Table 27

MANOVA for the 9, 6, 3 Group

Criterion	Test Statistic	F	DF	P
Wilk's	0.83	10.65	(8, 852)	0.000
Lawley-Hotelling	0.21	11.03	(8, 850)	0.000
Pillai's	0.18	10.27	(8, 854)	0.000

Utilizing degrees of freedom of either (8, 852), (8, 850), (8, 854), and a significance level of 0.05, the decision rule can be obtained. The critical F for all three tests noted in Table 27 is 2.02. Therefore, since the calculated F for all three tests is greater than the critical F, the null hypothesis of equality must be rejected in favor of the alternative hypothesis of inequality.

Based upon the MANOVA results from the testing of the three groups each operating under differing time constraints, null hypothesis five must be rejected in favor of the alternative hypothesis which states that the mean rate of: (a) idea generation, (b) creativity of ideas, (c) hierarchical idea categories, and (d) ideas chained is unequal in groups operating under differing time constraints.

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter contains information on the following: (a) the purpose of this study, (b) findings of the study, (c) implications for practice, (d) limitations of the study, and (e) areas for future research.

General

This study investigated the impact of time pressure on the mean rate of idea generation, the mean creativity rating of ideas, the mean number of idea categories generated, and the mean rate of idea chaining. The base theory for this study was Steiner's (1972) theory on productivity. This theory stated the following (p. 9):

Actual productivity = potential productivity - losses due to a faulty process.

Hypotheses were tested to determine if time pressure may be classified as a process loss as identified in prior research (Lamm & Trommsdorff, 1973; Diehl & Stroebe, 1987; and Albanese & Van Fleet, 1985). As noted by Steiner (1972) process losses resulting from a faulty process directly contribute to actual productivity.

One hundred and two undergraduate business students from Palm Beach Atlantic College took part in this research to gather data to investigate the basic research question. The research question in this study was the following: does the addition of time pressure into group processes impact group productivity, idea creativity, and idea chaining? To further investigate the research question, five hypotheses were tested utilizing both the ANOVA and MANOVA statistical techniques.

Conclusions of the Study

Few researchers have examined the issue of time pressure and group productivity, creativity, idea categories, and idea chaining (Wright, 1974; Christensen-Szalanski, 1980; Isenberg, 1981; Zakay & Woller, 1984; Bowden, 1985; and Kelly & Karau, 1993). This dissertation continued the research of Kelly and Karau (1993). However, rather than utilizing face-to-face groups, this study utilized a computerized group support system.

The objective of this research was to add to the current body of literature, specifically investigating the impact of time pressure on group productivity and creativity. Three distinct groups were observed, each operating under three specific time constraints.

Null hypothesis one stated that the mean rate of idea generation is equal among groups operating under differing time constraints. The null hypothesis was rejected, lending support to a variety of research dealing with idea generation (Yukl et al., 1976; Smith et al., 1982; Karau & Kelly, 1991; Kelly & Karau, 1993;).

Null hypothesis two stated that the mean rate of creativity of ideas is equal in groups operating under differing time constraints. The null hypothesis was rejected, lending support to prior research in this area (Karau & Kelly, 1991; and Kelly & Karau, 1993).

Null hypothesis three stated that the mean rate of the number of hierarchical idea categories produced is equal in groups operating under differing time constraints. The null hypothesis was rejected, lending support to prior research in this area (Lamm & Trommsdorff, 1973; and Kelly & Karau, 1993).

Null hypothesis four stated that the mean rate of the number of ideas chained is equal in groups operating under differing time constraints. The null hypothesis was rejected. Currently, no empirical research has investigated the impact of time pressure on idea chaining. Specifically noting the groups operating under the 9, 6, and 3 minute time constraint, as time pressure increased the mean values for idea chaining also increased.

Null hypothesis five stated that the mean rate of: (a) idea generation, (b) creativity of ideas, (c) hierarchical idea categories, and (d) ideas chained is equal in groups operating under differing time constraints. The null hypothesis was rejected. Currently, no other empirical research has investigated the statistical significance of these four dependent variables operating together in differing time periods.

Based upon the rejection of all five null hypotheses, support is given to Steiner's (1972) theory of productivity. Since the null hypotheses were rejected, it follows that time pressure can result in group process losses since varying time constraints reduce the mean values of the dependent variables.

Limitations of the Study

There are several limitations associated with this study. First, undergraduate business students were utilized in this study. Utilizing students in research that generates ideas may limit those ideas based upon the participant's limited experiences. Additionally, the students were given a portion of their final course grade for simply participating in the research. Therefore, the pressure felt by the students may not have been as great as that traditionally experienced in the business environment.

Second, the tasks used in this study were simplistic in nature. Although the tasks were taken from prior similar research and grounded in the literature, care should be taken when generalizing the results across all idea generating tasks.

Implications for Practice

The impact of time pressure on idea generation and creativity has several important implications for business. Examining the mean values for the four dependent variables points to several compelling implications.

Selecting Appropriate Time Periods

Examining the results of the ANOVA testing lends support to the concept of entrainment as identified by Kelly and Karau (1993). Therefore, initially placing individuals under high pressure situations seems to result in sustained high pressure performance even when these individuals are later given extended time to complete similar tasks. This can be readily observed by examining Tables 2 and 3. Conversely, when individuals are given longer initial periods to complete a task, these individuals increase their productivity as time pressure is increased. This can be observed in Tables 6 and 7.

Therefore, it follows that managers must carefully consider the time periods that employees are provided to complete tasks. Starting employees under high pressure conditions may create continued high pressure performance while providing too much time may be detrimental.

Generating Creative Ideas

One of the interesting findings of this study centers around the issue of idea creativity. Tables 8, 10, and 12 show surprisingly low mean scores for creativity. Therefore, the results of this study indicate that individuals under any time pressure condition generate ideas that are relatively low in creativity. Managers must recognize that placing individuals in time pressure situations may result in ideas of relatively low creativity.

Developing Synergy

The concept of synergy is a popular process gain derived from working in groups (Osborn, 1957; Gallupe et al., 1992; and Nagasundaram & Dennis, 1993). As noted in Chapter II, synergy occurs when information contributed from one group member is improved upon or used differently than intended based upon the greater knowledge of the group

(Gallupe et al., 1992). A closely related concept to synergy is idea chaining. This study produced an interesting practical application regarding idea chaining and time pressure.

Placing group members under time pressure resulted in relatively low mean scores for idea chaining. This can be seen in Tables 20, 22, and 24. Figures 11, 12, and 13 graphically portray the results regarding idea chaining. Utilizing the group support system allowed group members to see ideas of others and chain ideas if desired. It appears, however, that during the early 30 second time intervals as users were growing accustomed to the experiment, they watched ideas that were submitted by other group members. As time pressure increased and as group members became more familiar with the research process, there were dramatic reductions in idea chaining. Again, managers must understand that time pressure may force group members to be more concerned with their individual performance rather than taking time to review the ideas submitted by other group members.

Recommendations for Future Research

This study has generated additional areas where future research is warranted. This dissertation investigated four dependent variables. It is possible that further study utilizing different dependent variables may add significant information regarding the impact of time pressure on idea generation.

This study also utilized undergraduate business students to complete the research tasks. To better understand the impact of time pressure, it would be appropriate to further study this variable utilizing individuals from the business environment. Further research is appropriate for both non-management as well as management groups. Studying the differences and/or similarities between these two groups may also provide additional insights into time pressure studies.

Investigating differing research tasks is an additional area where further research is suggested. Previous studies utilize similar idea generation tasks, however, additional studies utilizing business environment tasks would be beneficial. Comments from the student participants in this dissertation research indicated that the idea generation tasks utilized in this study were not relevant to the business environment.

The facilitator in this study provided the time remaining for each exercise every 30 seconds. Observing Figures 2, 3, 8, 9, and 10 show that during the final 30 second intervals of the exercises, participants increased the mean scores of their tasks. Additional research in which the participants are not told the remaining time in the exercise would be beneficial to determine if this trend remains constant.

Additional research that examines differing time intervals as well as the time periods in which the exercises are conducted would also be beneficial. This study utilized 30 second intervals in which mean scores were determined and groups operated under either 3, 6, and 9 minute, 6, 6, and 6 minute, or 9, 6, and 3 minute conditions. Research that further investigates the time interval in which the mean scores are measured may provide additional insights and trends.

Very little research has investigated the concept of entrainment and it's relationship to time pressure (Kelly & Karau, 1993). This dissertation lends support to this concept, however, further study should be conducted to further investigate this relationship.

Finally, use of a group support system as a medium for time pressure studies provides another area in which continued research is desirable. Although the literature is rich in group support systems research, further investigation of process gains and losses as a result of group interaction continues to be of importance.

The group support system environment provides a fertile area for continued research including continued research in all of the areas discussed in Chapter II of this dissertation. Specifically, continued study of the group support system is warranted based upon the constant improvement and enhancement of both computer hardware and software.

Further research that identifies new process gains or losses that impact actual productivity will continue to provide new information to further investigate Steiner's (1972) productivity theory.

APPENDIX A

INTRODUCTORY FACILITATOR'S SCRIPT

INTRODUCTORY FACILITATOR'S SCRIPT

Hi, my name is Bob Myers. I have asked you to participate in a research project called "Creative Use Generation." This study investigates the generation of ideas from three person groups. As you know, many decisions in business today are made by groups. Therefore, the work done by groups is extremely important.

The use of Group Support Systems (GSSs) has recently become a very popular method of conducting business meetings. A GSS allows group members to conduct their meeting using computer hardware and software. A GSS allows you to enter your ideas while also seeing the ideas that other members are contributing. At any time you have the opportunity to comment on the ideas that others have submitted. Has anyone here ever used a GSS before?

You are asked not to discuss this research with anyone - including those who may have already participated. By discussing the study you may inadvertently give or receive information that will damage the integrity of the study and subsequently cause the entire research project to be ruined. If you have additional questions about the purpose of this study, I will be happy to answer those questions at the conclusion of the experiment. Also, at the end of the experiment I will provide cookies to all participants.

Shortly, you will be given the opportunity to use the GSS in a practice session. After the practice session you will be given specific instructions to use throughout the experiment. If you have any questions, please raise your hand now. Let's begin the practice session.

APPENDIX B

WARM-UP EXERCISE

WARM-UP EXERCISE

Instructions

This is a practice session for you to learn how a computerized group support system functions. Take a moment and look at your computer screen. You will see what looks like a page from a legal pad of paper. The page is empty with the exception of a title at the top of the page. Does everyone see this on your screen? If you do not see this please raise your hand.

On the top of this paper you will see several symbols. The only symbol who will use during the experiments today is the plus (+) symbol. Using your mouse, move the pointer directly over the "+" and click once. You should now see a box at the bottom of your screen that allows you to type your ideas. If you do not see this please raise your hand.

Under this box there are several options, however, the only option you will use today is the option labeled "submit." Type your name in the box and when you have completed this use your mouse to move the pointer over the "submit" option. Click the left mouse button once. You will see your name appear on the computerized sheet of paper on your screen. You should also see the names of everyone else on the top part of your screen. If you do not see the names of others or don't see your own name please raise your hand.

Next to other participant's names you will notice a red exclamation point. The exclamation point is an indication that the information you observe was typed in by someone other than you.

As we proceed through experiments tonight, your ideas and the ideas that others submit will all appear on your screen. Again, the ideas submitted by others will be proceeded by the exclamation point. As your computerized piece of paper fills with ideas, you will notice a gray bar on the right of the "paper." The bar will have two arrows on it - one arrow points up while the second arrow points down. This is called a scroll bar and is used to move the page up or down so you can see all the ideas submitted after the first page fills.

Do not be concerned if you misspell a word. Please just keep going and concentrate on your ideas - not your spelling.

You now know all the computer software options that you will use during our experiments. Do you have any questions?

In a moment you will be given the practice problem to work on. Please type in ideas that you believe would be creative and feasible solutions to the problem. Also feel free to build from the ideas that others have submitted.

Please use the following rules: (a) do not criticize the ideas of others, (b) the wilder the idea the better, (c) the more ideas you submit the more the likelihood of finding the winning ideas, (d) the combination and improvement of ideas submitted by others is desired, and (e) confine your work to the computer - do not talk to, look at, or signal others in the group. If you have any questions about what has just been discussed please raise your hand now.

Practice Problem

Here is your practice problem: Imagine what would happen if everyone born after the year 2000 had an extra thumb on each hand. The extra thumb will be built just like the present one is, but it will be located on the other side of the hand. It faces inward so it can press against the fingers, just as the regular thumb does now. Now the question is : what benefits or difficulties will arise when people start having this extra thumb? You have 6 minutes to practice with the GSS hardware. If you have questions during the practice session, please raise your hand and I will assist you. I will tell you when the practice session is over. You may now begin typing in ideas.

APPENDIX C

PRE FIRST TRIAL SCRIPT

PRE FIRST TRIAL SCRIPT

In a moment you will be shown a common object. When you are told to begin, your task is to generate creative and unusual uses for the object. It is important that you focus both on how many ideas you can generate as well as the originality and feasibility of the uses. You are asked to develop as many ideas as possible for each object. You have 3 minutes to complete this task. Every 30 seconds the GSS system will automatically measure your progress. At each 30 second interval I will give your group the time that you have remaining in the experiment.

For the entire experiment, you must only interact through the GSS. You may not speak with other members of the group and you may not speak with me. Please use the following guidelines: (a) you may not criticize the ideas of others in your group, (b) the wilder the idea the better, (c) the greater the number of ideas, the more the likelihood of finding the best solution, and (d) the combination and improvement of ideas submitted by other group members are desired.

When I tell you the experiment is over, immediately stop typing and sit quietly for a moment. A questionnaire and pen will be given to each of you. Please follow the instructions on the questionnaire. Select the response that you believe best answers each question. I will not be able to answer any questions about the questionnaires. When you have finished the questionnaire, please sit quietly and raise you hand. I will then collect your questionnaire and pen. When everyone has completed the questionnaire, you will be asked to perform a second task. You will be told about that task at a later time.

Are there any questions? Here is the object for this experiment. When I tell you to begin, you may start typing as many creative and unusual ideas you can think of for use of the object. You may begin now.

APPENDIX D

PRE SECOND TRIAL SCRIPT

PRE SECOND TRIAL SCRIPT

In a moment you will be shown another common object. This object is different than the one used during the first part of the experiment. When you are told to begin this segment of the experiment, your task is to generate creative and unusual uses for this object.

It is important that you focus both on the number of ideas you can think of as well as the originality and feasibility of the uses. You are asked to develop as many ideas as possible for the object. You have 6 minutes to complete this task. Every 30 seconds the GSS system will again automatically measure your progress. At each 30 second interval I will give your group the time remaining for the experiment.

For the entire experiment, you must only interact through the GSS. You may not speak with other members of the group and you may not speak with me. Please use the following guidelines: (a) you may not criticize the ideas of others in your group, (b) the wilder the idea the better, (c) the greater the number of ideas, the more the likelihood of finding the best solution, and (d) the combination and improvement of other ideas submitted by group members are desired.

When I tell you the experiment is over, immediately stop typing and sit quietly for a moment. Another questionnaire and pen will be given to each of you. Please follow the instructions on the questionnaire. Select the response that you believe best answers each question. The items on the questionnaire refer to this second experiment only. I will not be able to answer any questions about the questionnaires. When you have finished the questionnaire, please sit quietly and raise you hand. I will then collect your questionnaire and pen. When everyone has completed the questionnaire, you will be asked to perform a third task. You will be told about that task at a later time.

Are there any questions? Here is the common object for this experiment. When I tell you to begin, you may start typing as many creative and unusual ideas you can think of for this object. You may begin now.

APPENDIX E

PRE THIRD TRIAL SCRIPT

PRE THIRD TRIAL SCRIPT

In a moment you will be shown a final common object. This object is different than those used during the first two parts of the experiment. When you are told to begin this segment of the experiment, your task is to generate as many creative and unusual uses that you can think of for the object.

It is important that you focus both on the number of uses you can generate as well as the originality and feasibility of the uses. You are asked to develop as many ideas as possible for this object. You have 9 minutes to complete this task. Every 30 seconds the GSS system will automatically measure your progress. At each 30 second interval I will give your group the time that is remaining for the experiment.

For the entire experiment, you must only interact through the GSS. You may not speak with other members of the group and you may not speak with me. Please use the following guidelines: (a) you may not criticize the ideas of others in your group, (b) the wilder the idea the better, (c) the greater the number of ideas, the more the likelihood of finding the best solution, and (d) the combination and improvement of ideas submitted by other group members are desired.

When I tell you the experiment is over, immediately stop typing and sit quietly for a moment. Another questionnaire and pen will be given to each of you. Please follow the instructions on the questionnaire. Select the response that you believe best answers each question. The questionnaire refers only to your experiences during this third experiment. I will not be able to answer any questions about the questionnaires. When you have finished the questionnaire, please sit quietly and raise you hand. I will then collect your questionnaire and pen. When everyone has completed the questionnaire, you will be dismissed and the experiment will be concluded.

Are there any questions? Here is the common object for this experiment. When I tell you to begin, you may start typing as many creative and unusual ideas as you can into the computer system. You may begin now.

APPENDIX F

POST TRIAL QUESTIONNAIRE

POST TRIAL QUESTIONNAIRE

ID #:______________________ Date:_________________

Age:_________ Gender: M F Session:______________

Please complete the following questions. Circle the number on the 7-point scale that you believe best answers the question. For questions that ask for a written response, please PRINT your answer.

1. How satisfied were you with the computer application your group used to discuss this problem?

Very Dissatisfied			Neutral/ Undecided			Very Satisfied
1	2	3	4	5	6	7

2. Rate the quality of the ideas proposed.

Very Ineffective			Neutral/ Undecided			Very Effective
1	2	3	4	5	6	7

3. For this idea generation session, did you:

Have as much time as you needed			Neutral/ Undecided			Want more time
1	2	3	4	5	6	7

4. How do you feel about the ideas proposed?

Very Dissatisfied			Neutral/ Undecided			Very Satisfied
1	2	3	4	5	6	7

5. Rate the effectiveness of the ideas proposed.

Very Ineffective			Neutral/ Undecided			Very Effective
1	2	3	4	5	6	7

6. Did you feel rushed in recording your ideas?

Felt Rushed			Neutral/ Undecided			No Rush
1	2	3	4	5	6	7

7. Would you recommend this idea generation technique as a useful technique to others as a means of generating ideas?

Not Useful			Neutral/ Undecided			Very Useful
1	2	3	4	5	6	7

8. All in all, how satisfied are you with being a member of this group?

Very Dissatisfied			Neutral/ Undecided			Very Satisfied
1	2	3	4	5	6	7

9. Considering all the ideas you thought of, did you:

Have time to express all your ideas			Neutral/ Undecided			Not have time to express all your ideas
1	2	3	4	5	6	7

10. How effective was your group at generating ideas?

Very Ineffective			Neutral/ Undecided			Very Effective
1	2	3	4	5	6	7

11. How do you feel about the process by which you generated ideas?

Very Dissatisfied			Neutral/ Undecided			Very Satisfied
1	2	3	4	5	6	7

12. Did you have enough time to review other comments and ideas?

Ample Time			Neutral/ Undecided			Inadequate Time
1	2	3	4	5	6	7

13. How effective was your group at making use of members skills, abilities, and resources?

Very Ineffective			Neutral/ Undecided			Very Effective
1	2	3	4	5	6	7

14. Overall, how enjoyable did you find your experience in this group?

Not at all Enjoyable			Neutral/ Undecided			Very Enjoyable
1	2	3	4	5	6	7

15. What were the two things that you liked most about the meeting?

1.

2.

16. What were the two things that you did not like about the meeting?

1.

2.

APPENDIX G

CONCLUDING SCRIPT

CONCLUDING SCRIPT

Thank you for participating in this "Creative Use Generation" research. The experiment is now concluded. However, before you leave let me remind you not to discuss this research with anyone - including those who may have already participated. By discussing the study you may inadvertently give or receive information that will damage the integrity of the study and subsequently cause the entire research project to be ruined.

If you have specific questions, feel free to contact me after the study has concluded and I will be happy to answer those questions. Again, thank you.

APPENDIX H

IDEA CHAINING CODING SCHEME

IDEA CHAINING CODING SCHEME

This rater coding scheme was developed by Connolly et al. (1990). Raters must assign text into the first category which shows a good fit (i.e., first try to assign as PS; if this fails, try as SR; etc.).

Categories	Definitions
PS:	Proposes solution.
SR:	Supportive Remark. e.g., "Good idea"; "I like that". Expresses support for an idea without adding evidence or argument.
SA:	Supportive Argument. e.g., "I like that because...". Supports an idea and gives evidence or argument.
SCL:	Solution Clarification. Adds detail or new features to an idea.
PCL:	Problem Clarification. Adds detail or new features to the task.
CR:	Critical Remark. e.g., "That's a terrible idea". Expresses opposition to a proposal without adding evidence or argument.
CA:	Critical Argument. e.g., "A drawback to that idea is ...". Opposes an idea and gives evidence or argument.

QS: Query Solution. Requests clarification of a proposed idea.

QP: Query Problem. Requests clarification of problem specification or solution criteria.

COM, +/-: Positive, negative, or neutral remark about the computer network or its operation. e.g., "This system is too slow".

GRP, +/-: Positive, negative, or neutral remark about the interpersonal processes of the group. e.g., "Let's try to agree on something".

OTT: Remarks that are "off the topic" and do not fit into the existing categories.

UC: Uncodable text.

APPENDIX I

RATER CATEGORIES

RATER CATEGORIES

1. Jewelry
2. Securing Device
3. Clothing
4. Weapon
5. Toy
6. Gift
7. Food
8. Tool
9. Decoration
10. Weight
11. Musical Instrument
12. Money/Currency
13. Trap
14. Personal Hygiene
15. Electrical Device
16. Container

APPENDIX J

FIGURES

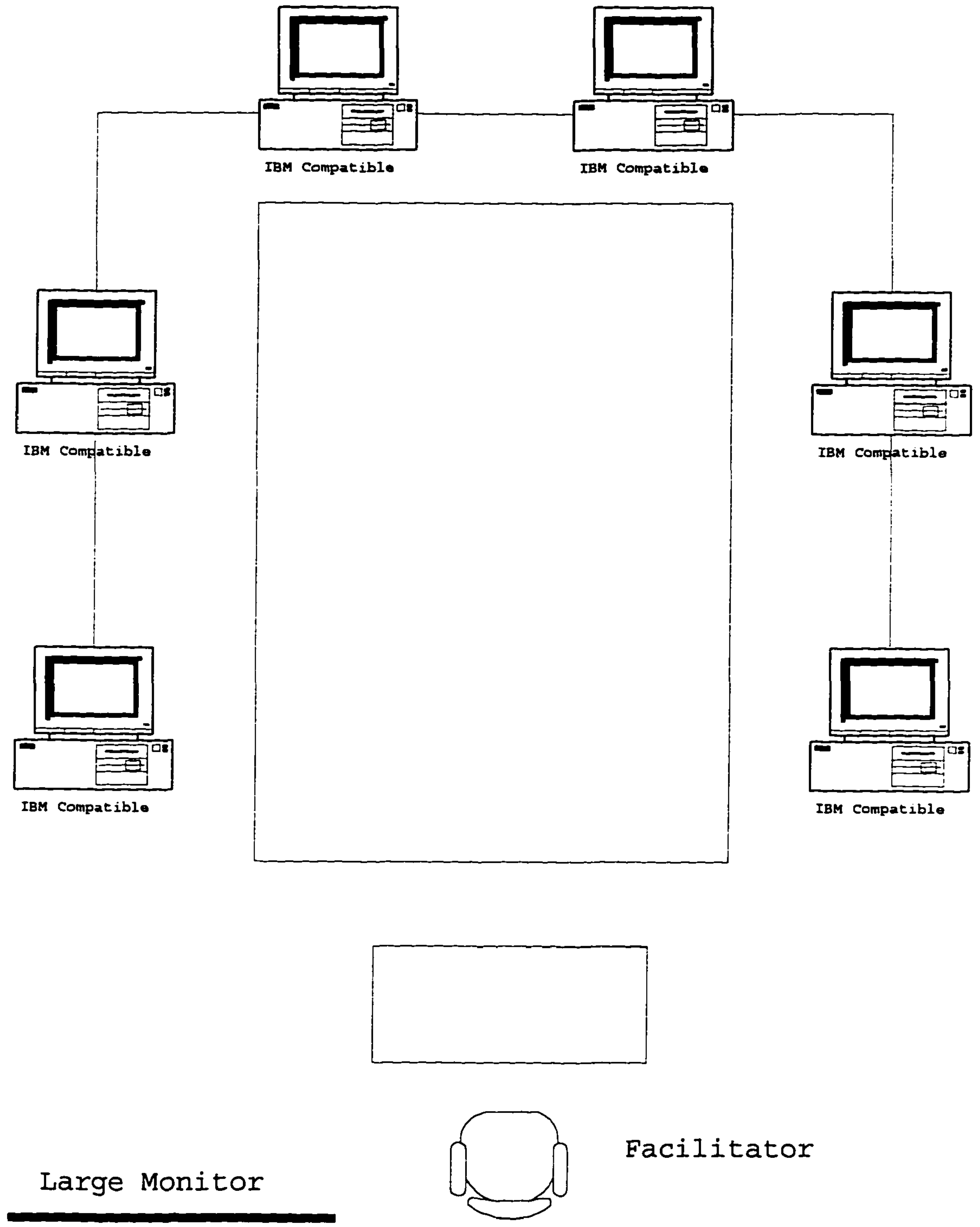
IBM Compatible
IBM Compatible
IBM Compatible
IBM Compatible
IBM Compatible
IBM Compatible
Facilitator
Large Monitor

Figure 14.

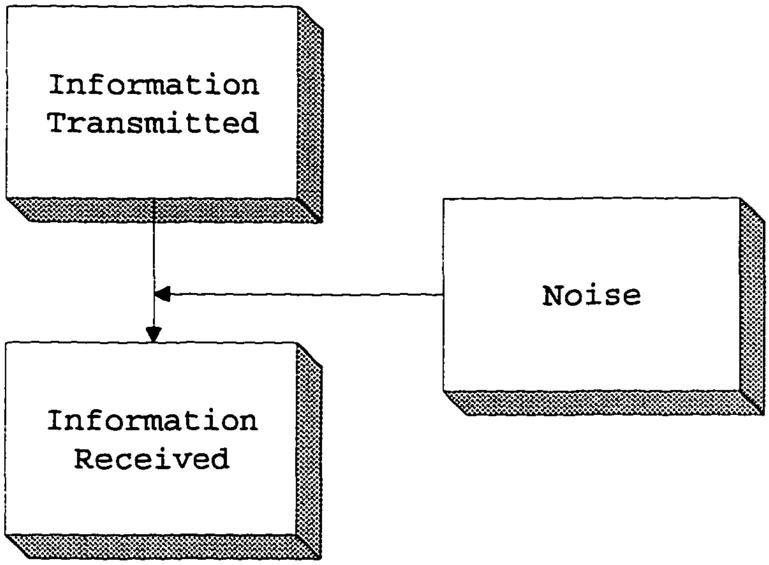

Figure 15.

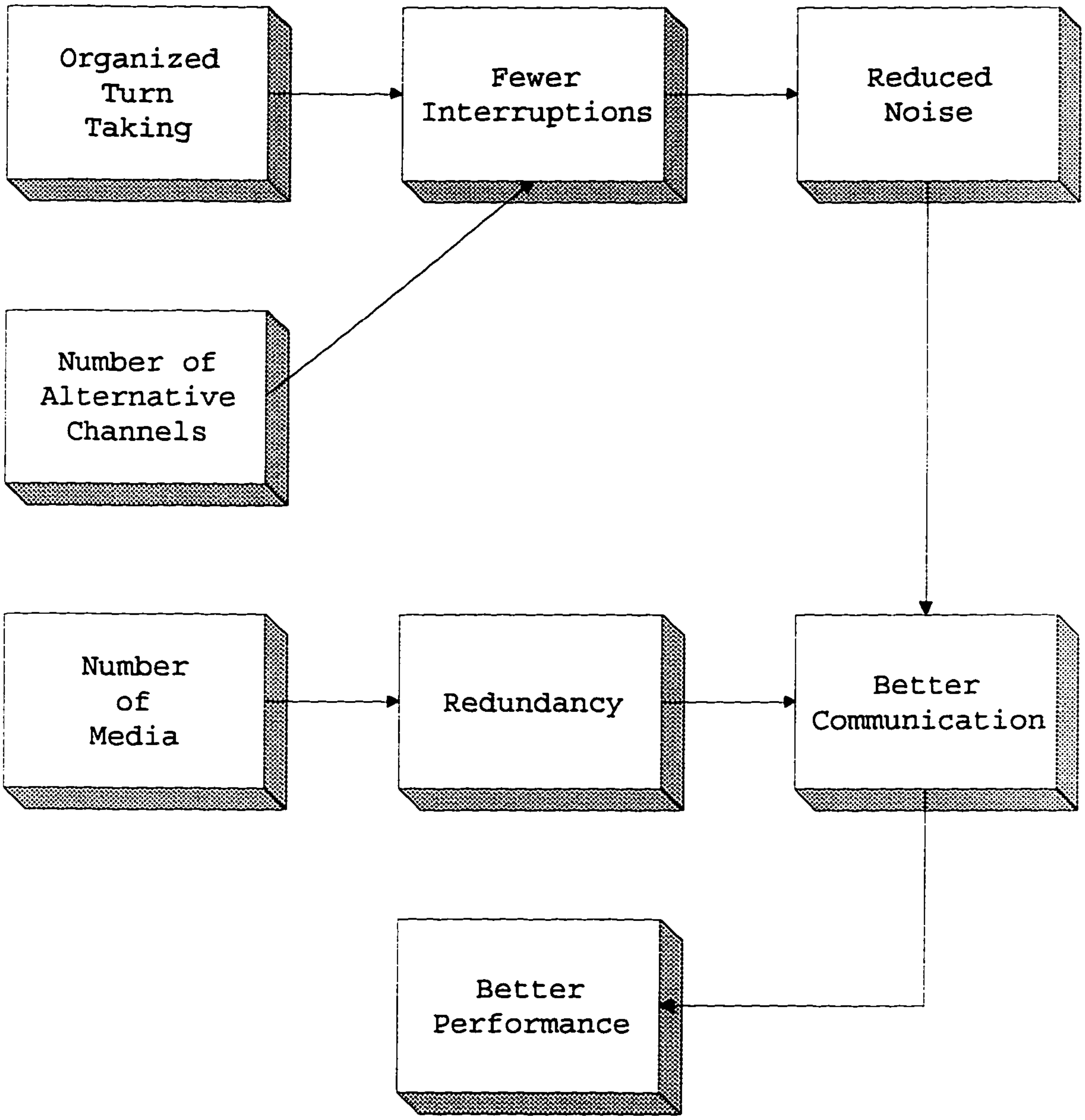
Organized Turn Taking
Fewer Interruptions
Reduced Noise
Number of Alternative Channels
Number of Media
Redundancy
Better Communication
Better Performance

Figure 16.

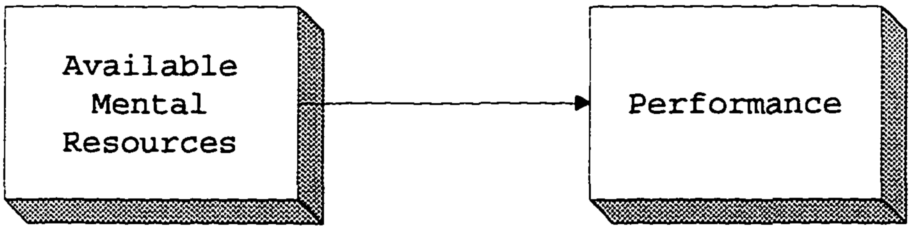

Figure 17.

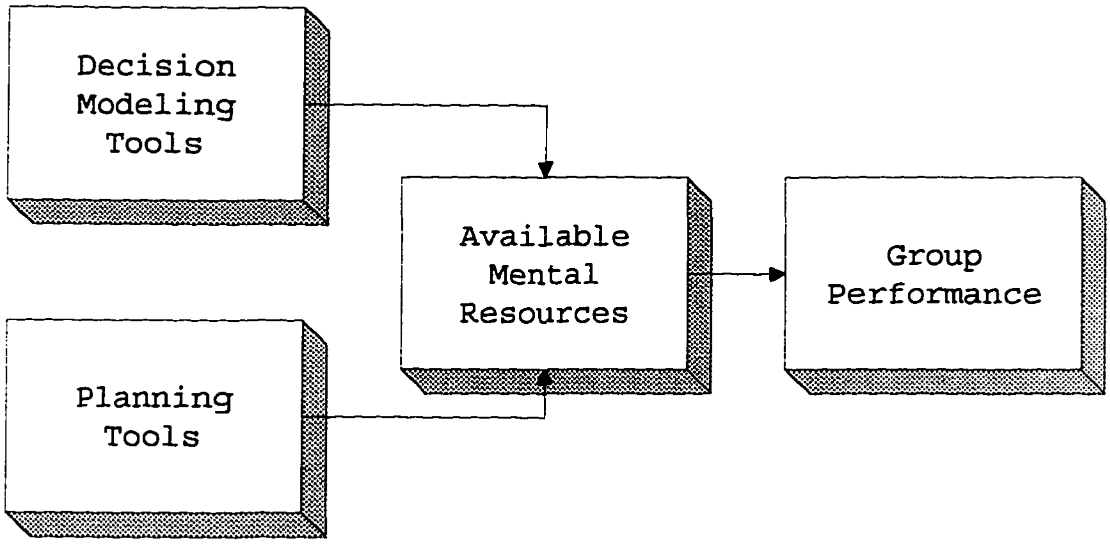
Decision
Modeling
Tools
Planning
Tools
Available
Mental
Resources
Group
Performance

Figure 18.

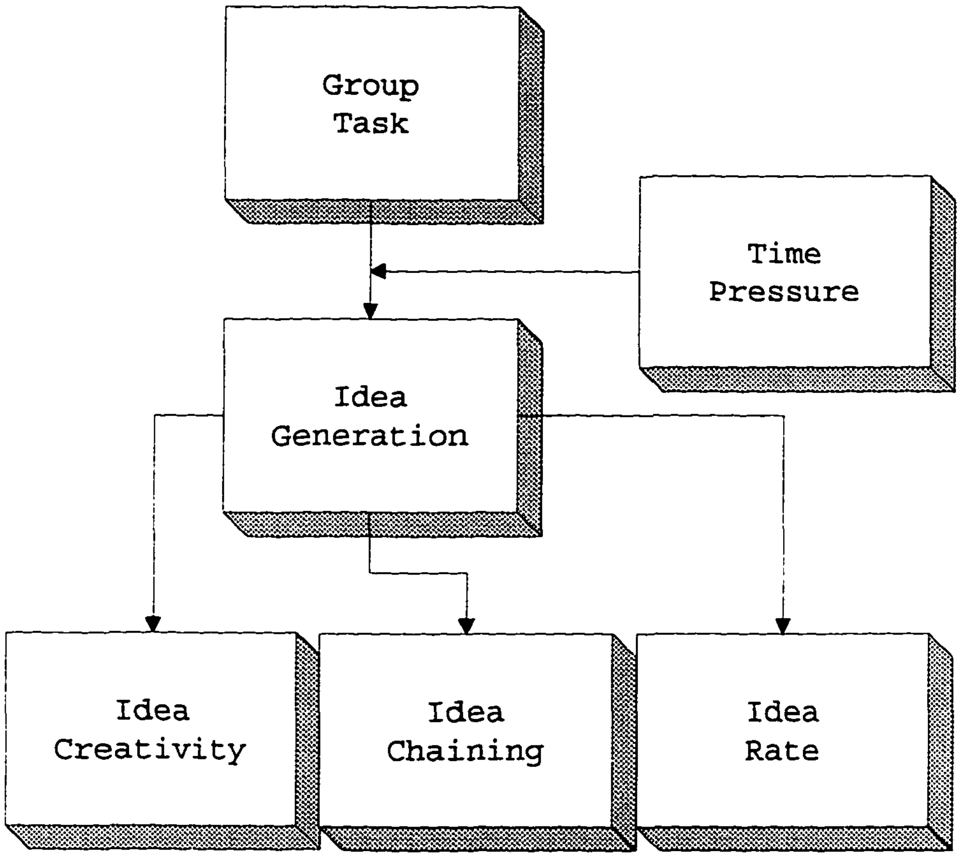
Group
Task
Time
Pressure
Idea
Generation
Idea
Creativity
Idea
Chaining
Idea
Rate

Figure 19.

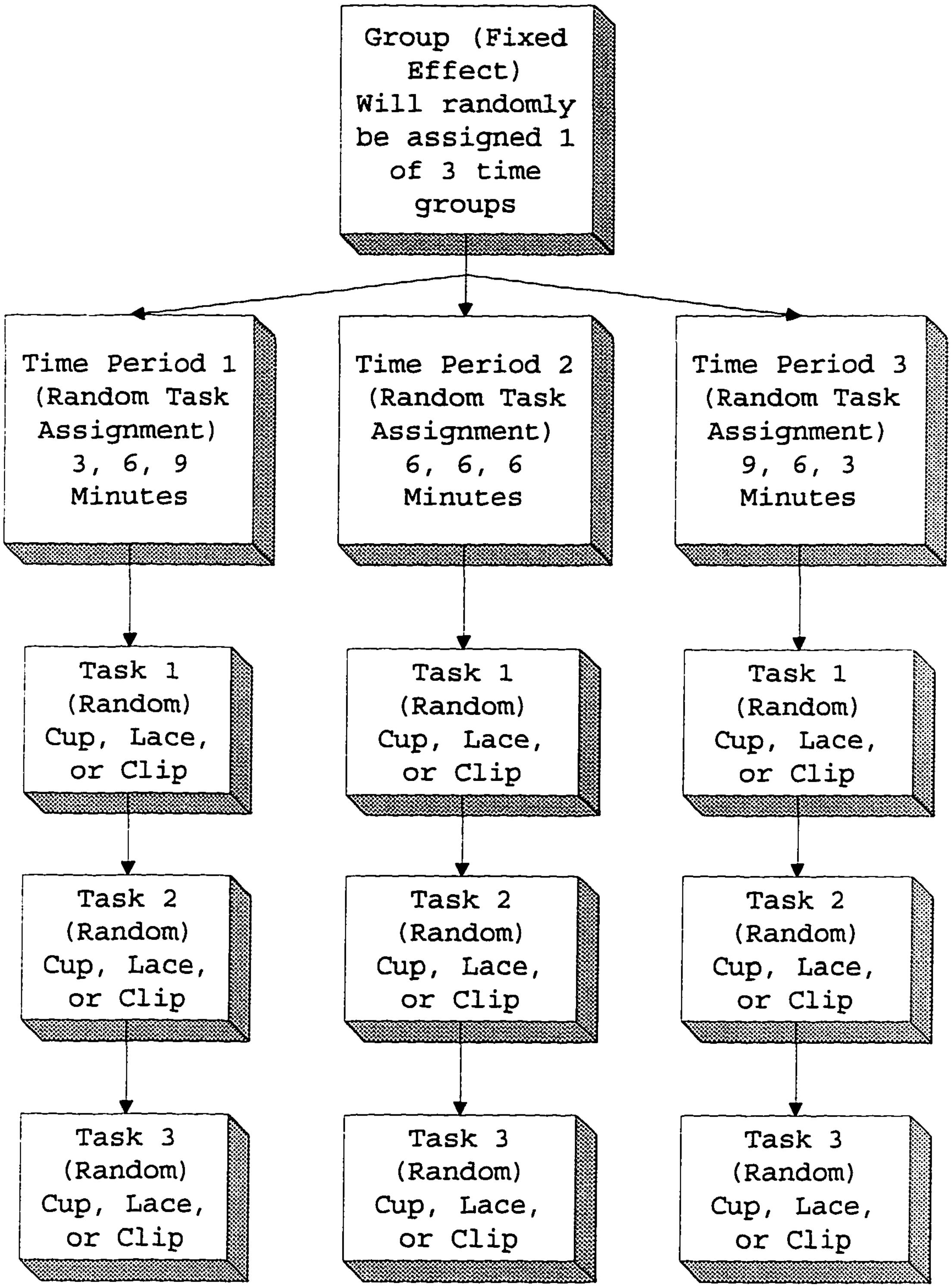
Group (Fixed Effect) Will randomly be assigned 1 of 3 time groups
Time Period 1 (Random Task Assignment) 3, 6, 9 Minutes
Time Period 2 (Random Task Assignment) 6, 6, 6 Minutes
Time Period 3 (Random Task Assignment) 9, 6, 3 Minutes
Task 1 (Random) Cup, Lace, or Clip
Task 2 (Random) Cup, Lace, or Clip
Task 3 (Random) Cup, Lace, or Clip

Figure 20.

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