

# **A Review of Brainstorming Research: Six Critical Issues for Inquiry**

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## **Abstract**

Brainstorming is one of the most well-known tools for creative thinking. Many empirical studies have been conducted regarding the effectiveness of this approach to group idea generation. Few previous reviews have considered more than one or two dozen studies and they have ignored a few fundamental issues outlined by the inventor of the tool. This condition has led to some unfortunate misconceptions about brainstorming. This article provides a review of 50 studies done from 1958 to 1988. They are examined on the basis of six major issues and interpreted by considering 40 additional studies conducted since 1988. The aim is to take stock of what we know and point out productive pathways for future research.

## Introduction

The purpose of this article is to critically review the empirical literature on brainstorming in light of six major issues which, together with their implications, challenge the prevailing paradigm and suggest entirely different pathways for improved research. Before presenting the results of the review, the term brainstorming will be defined and an abbreviated summary of how Osborn actually presented this well-known group approach to idea generation is given. The Yale study (Taylor, Berry & Block, 1958) that formed the foundation for a great deal of the empirical work will be summarized and examined in light of Osborn's suggestions and best-case application for brainstorming. The Beaton (1990) study results will be presented with a summary of more current brainstorming research organized around the six major issues. Finally, suggestions and recommendations for future brainstorming research will be provided.

Brainstorming is probably one of the most well-known tools of creative problem solving (Fernald & Nickolenko, 1993; Leclef, 1994; Stein, 1975). Its popularity stems from the long-standing and pervasive need to improve the productivity of groups. It is simple, easy to learn, and has potential to dramatically improve group idea generation and enjoyment with the activity itself. Brainstorming's widespread familiarity is also explained by the fact that it was introduced in 1939 by an advertising executive who had expertise and experience with the process of selling ideas.

In his widely-distributed book Applied Imagination, Osborn (1953) outlined a variety of tools and approaches to creative problem solving (CPS). He made some bold assertions regarding brainstorming's effectiveness. Osborn backed up his claims by indicating that, in one study, a group using brainstorming produced 44% more worthwhile ideas than individuals thinking up suggestions without the benefit of group discussion. Many were eager to try this new approach, and it quickly became a sensation. This increased popularity created some misunderstanding and misuse of the term and the tool. For those who jumped on the bandwagon, brainstorming had become the new panacea.

The word "brainstorming" has taken on a variety of popular meanings. For some it means simply to get together and have a casual discussion in order to come up with a few ideas. Some believe that the term brainstorming is the same thing as idea generation. For others, brainstorming is a universal treatment (the only way to be creative) or synonymous with the entire CPS process. For others, it was used as a derogatory term implying a waste of time.

During a recent conference, one National Science Foundation official indicated that "...we all know that brainstorming is nothing more than executive entertainment." Current and popular organizational consultants and writers have often referred to brainstorming as "cerebral popcorn," nothing more than a "crapshoot," or as a leading international authority on the direct teaching of creative thinking indicated:

*Those who want to use deliberate creativity believe that the (weak) processes of brainstorming are enough. Others who might be motivated to develop creative thinking skills are turned off by the "scatter-gun" approach of brainstorming. The idea that from a ferment of consideration an idea might emerge which might be useful has value in the advertising world (where brainstorming originated) but much less value where novelty is not, by itself, a sufficient value (de Bono, 1992).*

While the term "brainstorming" may be widely diffused, people hold various and

conflicting meanings for the term. For many professionals who work with individuals, groups, and organizations to educate and nurture creative abilities and skills, brainstorming has a specific and more technical definition. It may be helpful to examine in more detail how the original proponent described brainstorming.

## **Osborn's Best-Case Description of Brainstorming**

Osborn (1942, 1948, 1952a & b, 1953, 1957, 1963, 1967) felt that the creative productivity of groups was often hindered due to the primarily evaluative orientation of most meetings. His popular metaphor for this condition was described as “driving with the brakes on.” He designed the brainstorming session as a creative conference for the sole purpose of producing a checklist of ideas which can subsequently be evaluated and further processed. Brainstorming was identified as only one of a variety of tools for generating ideas, and idea generation was outlined as only one aspect of the entire creative problem-solving process. Group brainstorming was suggested as a supplement to individual ideation, not a replacement.

### ***The four basic guidelines:***

A central principle involved in brainstorming was described as “deferment of judgment,” which meant the postponement of judgment during generating phases of CPS. Osborn (1953) included deferment of judgment as only one of the four central guidelines for brainstorming to respond to the over emphasis of judicial thinking that dominated most meetings and conferences. The four guidelines he developed were:

1. Criticism is ruled out. Adverse judgment of ideas must be withheld until later. The purpose of the brainstorming session is the generation of many, varied and unusual options.
2. Freewheeling is welcomed. The wilder the idea, the better; it is easier to tame down than to think up. Since criticism is temporarily ruled out, it's acceptable and desired that really wild and unusual ideas are shared.
3. Quantity is wanted. The greater the number of ideas, the greater the likelihood of useful ideas.
4. Combination and improvement are sought. In addition to contributing ideas of their own, participants should suggest how the ideas of others can be turned into better ideas; or how two or more ideas can be joined into still another idea. (p 300-301.)

Although deferment of judgment was the central principle outlined by Osborn, he made it clear that judgment had an important role to play in the total CPS process. Since the purpose of brainstorming was for group generation of options, sorting and evaluation were postponed and became the main agenda for another separate meeting.

The four guidelines were central for successful brainstorming, but Osborn was clear that they were not sufficient. He outlined a number of considerations for managing groups and preparing for a productive session.

### ***Brainstorming designed for group application***

Since brainstorming was designed to be applied in a group setting, Osborn outlined many guidelines and suggestions for those who might choose to lead a brainstorming session. He recommended that these facilitators should take at least one formal course in creative problem solving and should be able to: ask stimulating questions, develop plans for guiding the generating of ideas, provide warm-up practice and orientation for the participants, teach and reinforce the guidelines, and manage the planning and scheduling of follow-up sessions and meetings, among other responsibilities.

The group of 5-10 participants should be selected based on the nature of the problem to be brainstormed. Mixing different levels of participants was to be avoided. Participants should generally be self-starters and have a range of experience with the task. Brainstorming sessions (which were to last from 30 - 45 minutes) also needed to be supported by someone to handle the recording and collecting of ideas during the session. This recorder was also prepared, in advance, by the leader of the session.

Since brainstorming was designed for group application, the session was designed to supplant individual ideation. Individual ideation was to happen prior to the group session and as a follow-up to allow for plenty of incubation time. Osborn was influenced by the work of Wallas (1926) who identified preparation, incubation, illumination, and verification as key aspects of the creative process.

### ***Preparation and training before using the tool***

Osborn recommended that preparation take place on two levels. First, the type of problem to be approached had to be carefully prepared. Next, the participants attending the session had to be oriented in advance or during the session.

The problem had to be clearly stated and focused for idea generation. The task had to be specific rather than general. It should provide a single target for participants' idea-generating efforts. Osborn recommended sending a one-page background and invitation memo with a few examples of the type of ideas desired by the problem owner. This preparation memo also requested individuals to generate ideas on their own in advance to the group session.

If the participants were not previously trained, Osborn recommended a 30-minute orientation provided by the leader of the session. Training on the brainstorming guidelines, as well as complementary tools and techniques to encourage ideation, were also recommended.

## **The Yale Study**

The debate regarding the productivity of brainstorming began during the 1950's and was characterized by widespread skepticism regarding Osborn's claims. The opponents of brainstorming believed that individuals working on their own would be more productive than those brainstorming in groups. Brainstorming in groups was considered an unnecessary waste of time and energy. Furthermore, the detractors believed that the effectiveness of brainstorming had been overstated and the tool simply did not deliver what it promised.

The brainstorming debate was fueled by an often-cited study (Taylor, Berry & Block, 1958) from Yale which examined the issue of group participation in brainstorming as having either a facilitating or inhibiting effect on creative thinking. The findings of the study indicated that individuals operating alone and using the brainstorming procedure generated more ideas than groups using the same procedure.

Although this study is often cited as evidence that brainstorming does not work, it is important to emphasize that this study did not actually test the brainstorming guidelines since both experimental conditions used brainstorming. The factor under examination was group versus individual use of brainstorming. The issue of group versus individual problem-solving performance was a core research interest of the authors (Taylor & McNemar, 1955) and they cited the studies of Lorge and Solomon (1955; 1959) as antecedents to their study.

The fact that Osborn presented brainstorming as a group procedure did not appear to influence the design or purpose of the study. Osborn's claim that a real group using brainstorming would outperform an individual working alone was not tested.

The Taylor, Berry, and Block (1958) study has provided the primary example and established a pathway upon which dozens of studies and reviews of brainstorming research have traveled. The primary emphasis has been upon the effects of group participation during brainstorming. The debate and surrounding research has most certainly enhanced our understanding of the inhibiting influence of groups on idea-generating behavior, but we need not prematurely abandon the productive applications of brainstorming. As a matter of fact, the receptive climate established in a brainstorming session was actually designed to reduce negative influences of groups on an individual's idea-generating behavior.

The Taylor, Berry, and Block (1958) study compared randomly assigned groups who worked together to generate ideas on three tasks to a randomly-assigned collection of individuals whose results were pooled after working alone on the three tasks. All participants in the study were encouraged to follow the guidelines for brainstorming. Thus, the comparison was between coacting (individuals interacting in real time and space) and nominal groups (individuals working alone and then results pooled after the fact). Working in nominal groups removes most of the moderating influences brainstorming was designed to overcome. Again, no attempt was made to test the actual guidelines for brainstorming because both experimental conditions followed the same guidelines.

The researchers did not attend to the suggestions and recommendations for the best-case application of brainstorming. The experimenters were familiar with the tool but had not been formally trained. The groups were not carefully selected based on the task. There were no leadership or recording roles within the group. The groups were randomly put together and given the same instructions regarding the guidelines for brainstorming as those in the individual condition. There was no special orientation for the group condition as required by Osborn.

The tasks included the Thumbs, Teachers, and Tourists problems. Undergraduate male students at Yale were asked to spend 12 minutes generating ideas for tasks like generating implications of waking up with an extra thumb, coming up with ideas for dealing with a shortage of teachers ten years in the future, and enticing more European

tourists to visit America. The Yale students did not have any time to prepare for the problems as they were presented as a part of the experiment. The problem statements themselves were not specifically set up for idea generation as outlined by Osborn. Instead of being set up for creative attack, the authors selected them because they invited logically correct solutions (Taylor & McNemar, 1955). The tasks were presented to the participants rather than defined with their participation and involvement.

The Yale study was embraced by those who were skeptical about brainstorming and was often misinterpreted as providing evidence of the failure of the tool. The study was aimed at investigating group versus individual differences when brainstorming and found that nominal groups were superior to real groups on quantity of options generated. Results were far less clear when the quality of those options was considered. The Yale study has provided the foundation for many of the studies that followed. These articles are the subject of the review of literature which is described in the next section.

## **A Review of the Literature**

Most brainstorming research has been conducted within a relatively confined paradigm, and previous reviews have examined only a handful of studies. Lamm and Trommsdorff (1973) reviewed sixteen studies and found that most of the brainstorming research utilized a similar experimental paradigm and statistical analyses. Stein (1975) provided a 116-page chapter that comprehensively reviewed the theory, guidelines, and outcomes of brainstorming research. Jablin & Seibold (1978) reviewed twelve studies in order to primarily address the question of individual superiority over groups when brainstorming. Ruback, Dabbs, and Hopper (1984) considered five studies and two previous reviews, but focused their attention upon examining the interaction process of brainstorming groups. Diehl and Stroebe (1987) conducted one of the most comprehensive reviews by considering twenty-one previous articles, but focused their attention upon the “riddle” of production blocking.

Although these previous reviews identified and reported a few consistent findings, there were some conceptual issues which created some confusion. Namely, what the various reviewers meant by brainstorming differed, the degree and kind of training varied widely, and what they appeared to be comparing was inconsistent with what Osborn claimed.

The rationale for conducting yet another review of literature starts with the need for a wider and more inclusive examination than previous reviews. Rather than use the Yale study as the antecedent basis, there is a need to conceptually recalibrate the review and identify issues and questions on the basis of what the original proponent claimed regarding brainstorming. In fact, one purpose of this review was to test the degree to which the shortcomings of the Yale study are reflected in the empirical literature.

Research on CPS tools, including brainstorming, should reflect a thorough understanding of their rationale and follow the directions for their best-case use. The results of this research should promote our understanding of their appropriate modifications and applications.

If a major purpose of brainstorming research is to shed light on ways to improve

group performance during idea generation, then much of the available research literature did not appear to be helpful. In order to obtain this kind of insight, an entirely new paradigm would need to be developed. This new approach must be based on a fundamentally valid conception of what brainstorming is and what it was designed to accomplish. Thus, a final purpose for this review is to point out future research questions.

Toward this end, 50 empirical studies representing thirty years of brainstorming research (1958 - 1988) were assembled (see Table 1). Studies from all the previous reviews, additional studies from reviewing the results of numerous searches of the Dissertation Abstracts, and ERIC and Psych Scan data bases were included. The reference sections from all the studies and reviews were assembled and checked for additional studies.

**Table 1.** *The 50 Studies Analyzed*

<b><u>Author/Authors</u></b>	<b><u>Year</u></b>	<b><u>Number of Studies</u></b>
Bayless	1967	1
Bouchard	1972	3
Bouchard, Hare	1970	1
Bouchard, Barasaloux, Drauden	1974	1
Brillhart, Jochem	1964	1
Buyer	1988	1
Campell	1968	1
Cohen, Whitmyre, Funk	1960	1
Collaros, Anderson	1969	1
Comadena	1984	1
Diehl, Stroebe	1987	4
Dillon, Graham, Aidells	1972	1
Dunnette, Campbell, Jaastad	1963	1
Firestien, McGowan	1988	1
Gerlach, Schutz, Baker, Mazer	1964	1
Graham	1977	1
Graham, Dillon	1974	1
Gurman	1968	1
Harari, Graham	1975	1
Hymans, Graham	1984	1
Jablin	1981	1
Jablin, Seibold, Sorenson	1977	1
Jablin, Sussman	1977	1
Lingren, Lingren	1965	1
Madsen, Finger	1978	1
Maginn, Harris	1980	1
Meadow, Parnes	1959	1
Meadow, Parnes, Reese	1959	1
Milton	1965	1
Necka	1984	1
Parloff, Handlon	1964	1
Parnes	1961	2
Parnes, Meadow	1959	1
Price	1985	1
Renzulli, Owen, Callahan	1974	1
Rickards, Aldridge, Gaston	1988	1
Rotter, Portugal	1969	1
Ruback, Dabbs, Hopper	1984	1
Street	1974	1
Taylor, Berry, Block	1958	1
Torrance	1970	2
Turner, Rains	1965	1
Weisskopf-Joelson, Eliseo	1961	1

From our review of this literature as well as from small-group and leadership research, and based on our experience with CPS and studying its impact in organizational and educational settings, we identified six major issues which, if addressed and better understood, might enhance future brainstorming research. The fifty studies were then examined to see how they handled these six issues (Beaton, 1990).

Another 40 empirical studies were identified by following a similar procedure outlined above, to cover the period from 1988 - 1998. These more recent studies were also reviewed on the basis of the six issues.

There was sufficient heterogeneity of approaches and results within this literature, despite the common use of the brainstorming term, to hold off on using meta-analysis. Indeed, one of the issues examined within this review is the variety of criteria utilized to assess the outcomes of brainstorming research. One of the major reasons for this review is to assist with the challenge of identifying appropriate moderator variables and improve the definition of criteria for inclusion or exclusion of studies upon which meta-analysis might be conducted (Rosenthal, 1984; Wolf, 1986). Based on this improved conceptual clarity, coding and analysis for future meta-analytic syntheses might be improved.

### ***The issues***

Based on the discrepancies between Osborn's (1953) descriptions of brainstorming and the study conducted by Taylor, Berry and Block (1958), the 50 studies were assembled and carefully read, taking note of how each handled the following six issues. Each of the 50 studies were coded based on a scaling system designed as a part of a master's project (Beaton, 1990). A database was created with results included from each study for more efficient analysis using Microsoft Works (version 2.0 for the Macintosh SE computer). The data from the coding sheets was analyzed to address the following six issues.

1. To what extent did the literature treat brainstorming as a group tool for idea generation? How many studies actually compared brainstorming to another real group procedure or a real group working on its own? This issue was a central concern due to the apparent and widespread misuse of the term brainstorming. Most of the literature appeared to compare a group procedure with nominal groups that never interacted and were assembled post facto (pooled individual effort). This, of course, would not satisfy the requirements of a direct study of brainstorming's usefulness or value.
2. To what extent did the empirical investigation into brainstorming address the issue of facilitation? Osborn was very clear about the need and importance of the leader's role in establishing a productive brainstorming session. How many studies actually used such a group leader in accordance with Osborn's original recommendations or current best practice?
3. To what extent did the empirical literature follow Osborn's guidelines and recommendations for training and preparing the group for a productive session? Osborn clearly outlined that this preparation was to include training in the use of the tool and an orientation to the task. How many studies provided appropriate training for participants and prepared them, in advance, with a memo and invitation to individually generate ideas and bring them to the group session?

4. To what extent did the tasks utilized in brainstorming research meet the guidelines set forth by Osborn? The type and preparation of the task was an important factor for the success of brainstorming as outlined by Osborn. The task should be prepared so as to promote ideation. The problem should be stated clearly and should be supported by enough key background to help the participant understand the need or desired outcome. What kind of tasks are actually utilized for brainstorming research?
5. To what extent did the subject sampling utilized in brainstorming research reach the target population outlined by Osborn? Since Osborn developed brainstorming to be applied in real organizational contexts, it is important to know how many studies sampled this population. This effects the overall generalizability and usefulness of the findings.
6. On the basis of what kind of measures or criteria were the outcomes of brainstorming research evaluated? Osborn recommended that evaluation should be done separately from idea generation. Best practice involves the problem or task owner in screening, selecting, and supporting the selected ideas. A group could also be employed to develop and strengthen a few selected ideas. How did the studies handle the evaluation of the results?

These six issues provided the framework for the review of the 50 studies collected and inspected by Beaton (1990) as well as the additional 40 empirical studies.

## **Results from the Analysis and Current Trends in Literature**

The results for each issue will be presented in this section. The results will include the analysis of the 50 studies as well as the additional, more current literature, examined by this review.

### ***Brainstorming as a Tool for Group Application***

Brainstorming has been defined as a group tool designed as a supplement to individual ideation and usually followed by another session designed to evaluate and develop options. The general finding that group participation inhibits ideative productivity during brainstorming does not clearly test the usefulness of the guidelines or the tool itself. Rather, it reinforces the original intention of Osborn, who found that the ideative productivity of groups was lacking. Taylor, Berry and Block (1958), in summarizing their influential study, stated "...the present experiment includes no evaluation of the basic rules of brainstorming - only an examination of the effects of group participation when using brainstorming" (p. 47).

Even though the authors made this point clear, the results were often misinterpreted as if the study were an actual test of the brainstorming rules (Gryskiewicz, 1980b; Parnes, 1963). Many readers concluded that this study proved the futility of brainstorming rather than raising the important and practical questions regarding the improvement of the creative collaboration of groups. To test the effectiveness of a group procedure, it would seem reasonable to make comparisons with groups as the common unit of analysis in brainstorming and non-brainstorming conditions, or brainstorming conditions against an alternative real-group procedure.

The broader issue of individual versus group decision making and problem solving is an important area of study (Hare, 1976; Janis & Mann, 1977; Lorge & Solomon, 1960; Maier, 1970; Mann, 1959; Van de Ven & Delbecq, 1971; Vroom, 1974; Vroom & Yago, 1988; Watson, Michaelsen & Sharp, 1991). The fact that the Yale study formed the prevailing paradigm for brainstorming research by comparing individual with group performance was unfortunate. Using the same tool of brainstorming for comparing both real and nominal groups created confusion. Many perceived that the Yale study was a test of brainstorming, not just another aspect of the individual versus group question.

The original concern regarding real-group productivity, addressed by Osborn more than 50 years ago, is probably even more pronounced today. Working as two or more individuals who influence each other through social interaction is an important organizational reality. Knowledge and expertise are often specialized and diffused among a number of individuals. Successful accomplishment of tasks often requires effective utilization of group resources. Broadening participation in decision making often increases the acceptance of change and working in groups may encourage the cooperative building of improved options and solutions (Bennis & Biederman, 1997; Galegher, Kraut & Egido, 1990; McLagan & Nel, 1995). Many organizations have found highly effective work groups to be very profitable and are investing in team building and other strategies to improve the quality of interaction (Goodman, et. al., 1986; Katzenbach, 1998; Katzenbach & Smith, 1992; McGovern, 1991; Zander, 1985).

A major issue for brainstorming research is what actually constitutes a real group. Hackman & Morris (1975) have argued that the primary reason there is such a disparity between the real-life practice of using groups and the empirical literature's lack of support for using groups in decision making is the artificial nature of the group used in a great deal of the research. Many brainstorming studies which address the issue of group versus individual participation utilize nominal groups, groups in name only, in comparison to real groups. Grysiewicz (1984) asked, "...to what degree is a disservice done to the understanding of creative problem-solving technology by referring to a control condition whose membership is determined randomly, after the fact, as a nominal group?" (p. 5).

In addition, it has been shown that the experience level, expertise, and competence of group members, group development level and kind of diversity within the group are important factors in understanding group productivity (Bottger & Yetton, 1987). For example, Watson, Michaelsen & Sharp (1991) found that newly formed groups were not as likely to process information well enough to take advantage of the knowledge that members bring to a group decision making setting. Further, their study calls into question much of the previous group decision-making research by supporting the value of group-consensus decision making in task forces and ongoing organizational groups. The entire notion of randomly pooling individual contributions and calling them nominal groups, runs contrary to a great deal of organizational reality and avoids dealing with necessary group development issues and concerns.

The review of the 50 studies showed that 34 of them did not actually test the ground rules of brainstorming. Most studies focused on individual versus group brainstorming rather than directly testing the brainstorming procedure. Even though this emphasis does not offer a direct or appropriate test of brainstorming, it is often misinterpreted in the literature as evidence of its failure as a group procedure.

The 16 studies of the 50 that did actually test the guidelines all found support for brainstorming. Only two of the 50 studies included a comparison between brainstorming and another group procedure (Parnes & Meadow, 1959; Price, 1985). A few studies compared brainstorming against an entire process or method, illustrating some of the confusion regarding the design and purpose of the actual tool (Bouchard, 1972; Madsen & Finger, 1978; Neçka, 1984; Price, 1985).

Some of the supportive studies were conducted by those who were clearly proponents of brainstorming and were working closely with its originator. For example, Meadow and Parnes (1959) found that when they compared trained subjects working in real groups using brainstorming to an alternative group approach calling for critical evaluation, significantly more good quality solutions were produced under the brainstorming condition. These results have been confirmed by other scholars (Gerlach, Shultz, Baker & Mazer, 1964; Parloff & Handlon, 1964; Price, 1985; Weisskopf-Joelson & Eliseo, 1961). The results have also been extended upon by other proponents (Firestien & McCowan, 1988; Meadow, Parnes, & Reese, 1959; Parnes, 1961; Parnes & Meadow, 1959).

Other supportive studies focus on examining a particular guideline for brainstorming. Torrance (1970) examined both dyadic interaction and subjects who worked alone, and provided a specific test of the hitch-hiking guideline (participants were explicitly encouraged to combine their ideas with the ideas of others). He found that those who used the guideline demonstrated more originality and flexibility as measured by the Torrance Tests for Creative Thinking. Others have found that when groups use deferred judgment, rather than other interactive or more critical approaches, they produce more ideas (Buyer, 1988; Diehl & Stroebe, 1987).

A more recent trend in the literature explores the reasons for the “failure” of brainstorming groups. These studies explore the concept of productivity loss in real brainstorming groups from three perspectives (Diehl & Stroebe, 1987; Mullen, Johnson, & Salas, 1991). One main reason for the decrease in group productivity is the fear of critical evaluation and desire of the participants to go along with the dominant or established pattern of idea generation. This has been called evaluation apprehension or uniformity pressure (Camacho & Paulus, 1995; Collaros & Anderson, 1969; Gyskiewicz, 1984; Maginn & Harris, 1980).

A second explanation for the decrease in group productivity is related to the concepts of social loafing and free riding within the broad area of social facilitation (Shepperd, 1993). Social loafing occurs when there is a reduction in motivation and effort when individuals work collectively compared with when they work individually or coactively (Harkins, 1987; Harkins, Latané, & Williams, 1980; Harkins & Petty, 1982; Karau & Williams, 1993; Latané, Williams, & Harkins, 1979). The free-riding effect is related to social loafing in that individuals may reduce their efforts and contributions to the group when they perceive that their personal efforts are dispensable (Olson, 1965; Kerr & Bruun, 1983; Williams & Karau, 1991).

Matching and the sucker effect are related to the concept of social loafing. Individuals working in groups may compare their performance with that of others and be motivated to match their performance to others in their group (Goethals & Darley, 1987; Paulus, Brown & Ortega, 1995; Paulus & Dzindolet, 1993; Seta, Seta, & Donaldson, 1991). Individuals may also lower their efforts to avoid being the sucker

of the free riding of other members of the group (Kerr, 1983; Orbell & Dawes, 1981).

The third major explanation for the decrease in group productivity is production blocking (Diehl & Stroebe, 1987; Lamm & Trommsdorff, 1973). Production blocking occurs in a brainstorming session when individuals need to wait to verbalize an idea because of some procedural limitation like only having one person recording each generated idea at a flipchart (Mullen, Johnson & Salas, 1991). Group members may be thinking of more ideas than they can actually produce because they are blocked by other peoples' talking, among other reasons.

A good reason for exploring these productivity losses would be to improve the application of real-group brainstorming. A promising line of research and development has been the area of electronic brainstorming (Nunamaker, Applegate & Konsynski, 1987; Gallupe, Bastianutti and Cooper, 1991). They offered electronic brainstorming to enhance the creative capacity of brainstorming groups by overcoming the limitation of individuals being unable to express their ideas because others are talking. This line of research is increasing in empirical interest and support (Dennis & Valacich, 1993; Dennis & Valacich, 1994; Gallupe & Cooper, 1993; Gallupe, Cooper, Gris e & Bastianni, 1994; Gallupe, Dennis, Cooper, Valacich, Bastianutti & Nunamaker, 1992; Paulus, Larey, Putnam, Leggett & Roland, 1996).

In general, however, most researchers concerned with productivity losses in brainstorming groups are still utilizing the prevailing paradigm concluding that brainstorming is counterproductive. Most of the research on brainstorming has followed the example set by the Yale study in which the question was group versus individual productivity. Many researchers promulgate the false conclusion that the studies have examined the efficacy of brainstorming itself. For example, Mullen, Johnson, and Salas (1991) indicated:

*It appears to be particularly difficult to justify brainstorming techniques in terms of any performance outcomes, and the long-lived popularity of brainstorming techniques is unequivocally and substantively misguided...although the results of these analyses provide a damning indictment of the efficacy of the brainstorming technique, at least it does not seem to be the case that people in brainstorming groups are under-productive on purpose (p. 19-20).*

This general attitude is also found in Diehl and Stroebe (1991) as they claim overwhelming empirical evidence for brainstorming's ineffectiveness and conclude that "...group sessions should not be used to generate ideas" (p. 402). Others have gone even further in explaining why groups have the illusion of productivity (Rowatt, Nesselroade, Beggan & Allison, 1997; Stroebe, Diehl & Abakoumkin, 1992).

Future brainstorming research ought to focus on the group application of the tool and ways to increase the productivity of individuals functioning within the group context. More productive outcomes for brainstorming research may be found if the focus could be turned toward the necessary qualities of effective groups (Bales, 1985; Larson & LaFasto, 1989) and elements of effective working teams (Hackman, 1990) instead of avoiding groups. Working in real groups is far more often the case rather than working in contrived or randomly-assigned nominal groups. The emphasis should be upon improving our understanding of how real groups and teams can be helped to be more productive and how brainstorming might play a more helpful role.

Some specific testable questions might be centered on further examination of the

four guidelines for brainstorming. For example, future research could compare the relative strength of effects for each of the guidelines. Additional studies could focus on comparing brainstorming to other specific tools for generating ideas, rather than methods or more complete procedures. Another key area for further research is exploring the moderating effects of group diversity and size upon brainstorming productivity (quantity and quality).

When using the brainstorming procedure with groups, it is important to remember that the group may need a variety of mediating strategies to keep the energy high and produce many, varied, and unusual options (McFadzean, 1997). It is the responsibility of the facilitator to provide these strategies to keep the group productive. This aspect of group leadership will be reviewed in the next section.

### ***Group Leadership and Facilitation***

When applying most small-group problem-solving procedures there is usually at least one person who is familiar with the approach and provides a special group-oriented type of leadership (Kinlaw, 1993 & 1996; Rees, 1991). A facilitator is trained in the tool, is responsible for the process and procedures, structures and prepares the environment, reinforces roles and ground rules for the session, focuses the resources of the group, and is sensitive to a variety of group dynamics. During a typical CPS session, a group is led by a facilitator (Firestien & Treffinger, 1983, 1989; Isaksen, 1983, 1992; Isaksen & Dorval, 1996; Parnes, 1985; 1992; 1997; Treffinger & Firestien, 1989).

Brainstorming was designed with the facilitator as an essential part of the procedure, yet this need was not always clearly reflected in the empirical literature. What effect did facilitation, or lack thereof, have on group participation and the outcomes of brainstorming sessions?

Another reason for the importance of the facilitator role is that brainstorming was presented as only one tool for group idea generation (Osborn, 1953; Isaksen, Dorval & Treffinger, 1998). It was never designed to function alone as an entire process. Brainstorming was presented as just one of many CPS tools. It was apparent (even to Osborn) that brainstorming would be supplemented by other idea-generating tools and strategies (Neçka, 1985). It is the social role of the facilitator to bring to bear a variety of these tools and techniques during the session.

Results showed that only seven of the 50 studies utilized a facilitator. Two of these seven studies (Gurman, 1968; Taylor, Berry and Block, 1958) had a designated person reinforce the no judgment guideline. The remaining five studies actually used a group leader and they found support for the productivity of brainstorming (Bayless, 1967; Brillhart & Jochem, 1964; Meadow & Parnes, 1959; Meadow, Parnes & Reese, 1959; Rickards, Aldridge, & Gaston, 1988).

Since proper group leadership was not provided for the vast majority of studies, the best possible application of the tool was not often tested. This is a significant issue in light of the current trend in the literature to explain why groups are not as effective as individuals during brainstorming. Perhaps, if more studies were designed to include the role of facilitator, a better understanding of methods and procedures for increasing group effectiveness would result. This recommendation is supported by at least three recent studies (Clawson, Bostrom & Anson, 1993; Oxley, Dzindolet & Paulus, 1996; Offner, Kramer & Winter, 1996).

Offner, Kramer and Winter (1996) indicated:

*Virtually all of the brainstorming research in recent years places participants in groups where there is no attempt to actually manage or facilitate their behavior. There is no structure that is imposed, no assistance, and no aids such as a flip chart. In addition, the subjects are almost always newly formed groups, so there are no established norms to guide group interaction. Laboratory research of this sort seems totally divorced from reality and represents a clear "disconnect" between research and practice. (p. 298)*

They found that those groups having a trained facilitator generated significantly more ideas than those without one. Oxley, Dzindolet, and Paulus (1996) supported this finding and added the investigation of level of training of the facilitator. They found that the actual expertise of the facilitator had an impact on performance. In general, having a trained facilitator in the real groups enabled them to achieve the same level of productivity as nominal groups.

Future brainstorming research might benefit from examining a number of specific facilitation issues. What amount of the outcome variance can be accounted for by specific verbal and non-verbal facilitator behaviors? What amount and kind of training, skills, and knowledge are most helpful for facilitators? Can a member of the group who is randomly assigned the facilitator's role be as effective as someone who is professionally trained?

Training is not only important for the facilitator. Osborn recommended that the participants involved in the brainstorming session should also be prepared. The next section summarizes the findings regarding the amount of training provided to participants in brainstorming studies.

### ***Training in Using the Tool***

The issue of training revolved around the amount of time actually spent training the subjects in the use of the tool prior to, or in conjunction with, the research study. It is reasonable to expect subjects to perform better on process-oriented approaches when they have been trained in their most effective application. The amount of time spent on training would undoubtedly have an impact on the productive application of the tool. Best-case contemporary practice (Parnes, 1992 & 1997; Parnes, Noller & Biondi, 1977; Isaksen, Dorval & Treffinger, 1994) is to provide an introduction to the tool on a task which is not especially important to the group and then provide facilitated application on a real problem or challenge. The group is then led through a debriefing session and the learning is applied in the real session.

The impact of even brief training on group idea-generating performance is illustrated by Smith (1993). Groups receiving only five minutes of training on discounting (verbal or non-verbal criticism) and its effects on group ideation significantly outperformed groups in which discounting occurred. Those groups trained to avoid discounting produced significantly more ideas and had more positive perceptions of their interpersonal working climate.

For the purposes of this review, subjects were considered trained if they received a minimum of 30 minutes or more of direct instruction. Using this standard only seven of the 50 studies utilized trained subjects. The studies which utilized training all reported support for the brainstorming guidelines (Cohen, Whitmyre & Funk, 1960; Firestien & McCowan, 1988; Meadow & Parnes, 1959; Meadow, Parnes & Reese, 1959; Parnes & Meadow, 1959; Parnes, 1961; Rickards, Aldridge & Gaston, 1988). Brainstorming groups that were trained produced more ideas than individuals

working alone or groups using other procedures. In many cases no evidence was provided about the qualification of the trainer. When qualifications were listed, often they were limited to the researcher having read the rules of brainstorming.

If we are really to understand how to improve group performance, it appears that the kind and amount of training should be an important issue for future brainstorming research. Researchers ought to do more than simply read the guidelines prior to conducting studies. A thorough understanding of the dynamics and nuances of the tool should be sought. As Stein (1975) has indicated:

*It would seem that experimenters take too much for granted, or else they believe in the magic of instructions if they regard their instructions as setting their subjects as good representatives of a problem-solving technique. It would seem that the technique is better represented by subjects who are practiced and experienced in using it. This holds for brainstorming, critical problem solving, or whatever. (p.140)*

Future inquiries need to include an emphasis on the kind and duration of training and their effects on brainstorming productivity. For example, do certain kinds of training and preparation for brainstorming groups provide significantly different results with similar groups and tasks?

Preparation for a productive session includes providing an appropriate orientation for the participants. It also includes carefully selecting and preparing the task which is to be brainstormed. The following section reviews the kinds of problems and challenges used in brainstorming research.

***Types of Problems***

In examining the brainstorming studies, the kinds of tasks upon which groups and individuals are asked to work may effect the quality and quantity of outcomes (Watson, Michaelsen & Sharp, 1991; Zagona, Willis & MacKinnon, 1966). The vast majority of studies, in order to maintain appropriate comparisons, used the same few problems which were generally unreal, presented, and for which the group had no ownership. A challenge or task has ownership if it: is of interest, can be acted upon or actually influenced by a member of the group, or if it engages the imagination of the problem solver because it demands a fresh new approach which is meaningful (Isaksen & Treffinger, 1985; Isaksen, Dorval & Treffinger, 1994). Our analysis found that only eight of the 54 actual tasks used in the 50 studies could be described as having ownership (see Table 2).

The thumbs problem was used 19 times in the 50 studies and involved having subjects list the benefits and drawbacks of having an extra opposing thumb. Having subjects gen-

**Table 2.** *Problems and Tasks Utilized*

<b><u>Problem or Task</u></b>	<b><u>Number of Times Used</u></b>
Thumbs	19
Tiny people	13
Teacher	9
Hanger	9
Tourist	6
Energy	6
Broom	5
Brand names	3

erate unusual uses for a hanger or broom was the task used 14 times in the 50 studies. The tiny people problem dealt with listing all the consequences of people waking up and suddenly finding themselves very tiny. This was used 13 times in the studies. The tourist problem involved generating ideas to lure European tourists to the United States and it was the task used 11 times for the 50 studies. Finally, the teacher problem entailed listing ideas in order to ensure there would be enough teachers to meet the needs in the future and was used nine times.

Current approaches to CPS rarely approach brainstorming in the manner described in the mainstream of the empirical research (Isaksen & Treffinger, 1991; Isaksen & Dorval, 1993, Isaksen, Dorval and Treffinger, 1994; Parnes, Noller & Biondi, 1977; Treffinger & Isaksen, 1992; VanGundy, 1992). At best, challenges like the ones used in the research would only be used to warm-up the group or to introduce them to brainstorming.

A real problem-solving task would not suddenly appear as a well-defined (and artificial) problem. Prior to generating ideas, some energy would be invested in preparing and understanding the problem. Following idea generation some deliberate time and effort would be spent developing and evaluating the selected ideas, and a plan for implementing tentative solutions would be created. Our analysis found only one study allowed the problem to be discovered, the other 49 studies used presented tasks (Maginn & Harris, 1980).

The kind of task would be expected to influence the results of a brainstorming session. Green (1975) found that when students were asked to generate problems rather than ideas on an environmental challenge, there were no significant differences between real and nominal group performance. This finding held for the number of responses generated, the number of unique responses and the total quality of problem statements generated. It should be noted that these findings were contradictory to those of Gustofson, et. al. (1973) and Van de Ven and Delbecq (1974).

It would appear that most of the empirical literature falls short when considering the reality of the tasks used to study brainstorming. It appears that this criticism also applies to a great deal of research on individual versus group problem solving. Watson, Michaelsen and Sharp (1991) found that many aspects of the tasks in the research were very artificial. They stated:

*...most studies required subjects to work on a task that was both trivial in nature and foreign to the setting in which it was employed...and no studies provided any significant outcome, positive or negative, for either individual or group performance. More important, from the standpoint of the current study, the vast majority of studies utilized data from groups that existed only for the duration of the data collection...usually less than one hour. (p.803-804)*

Future research should focus more on the kinds of challenges and opportunities upon which brainstorming was designed, rather than utilizing contrived and presented problems for which ownership is lacking. Will those who engage in brainstorming produce more and better ideas if they are generating upon a task for which they have ownership? Will different individuals be invited to join a brainstorming session by the client based on the task? What kind of task qualities account for most of the variance when considering the quantity and quality of outcomes? Are there particular methods for presenting the actual brainstorming task which may improve group productivity?

Most existing brainstorming research presents the subjects with the problem and then asks them to generate ideas. Thus, brainstorming is usually confined to an idea-generating activity. Contemporary approaches to CPS use the brainstorming guidelines for generating many, varied, and unusual options throughout the entire process (Isaksen, Dorval & Treffinger, 1994 & 1998; Isaksen & Treffinger, 1991; Treffinger & Isaksen, 1992). For example, these same guidelines work very well when generating problem statements, evaluation criteria, or action steps. Future brainstorming research should consider broadening the type of tasks to include those which are real as well as those focusing on problem defining, evaluating, implementing, or other aspects of the entire creative problem-solving process (Isaksen, 1988).

The kinds of tasks, problems, and challenges utilized by most empirical studies of brainstorming are artificial. In an effort to conduct research that can be easily compared, most studies have used a rather confined set of tasks. The tasks were usually not presented in a manner consistent with Osborn's guidelines. We now turn to the topic of the subjects used in most of the research.

### ***The Samples Utilized***

The kinds of samples utilized for brainstorming studies may effect the results and applicability of the findings. Although Osborn believed that brainstorming belonged in schools and should be taught and used by students, he was addressing a perceived need for the adult professional world when he developed the tool and the more general CPS process. Only four of the 50 studies utilized adults. College students were used as subjects in 45 of the 50 studies examined. Only males were utilized in 11 studies. One study used children.

Although college students are convenient samples for most academic researchers, this finding offers a serious limitation for the current understanding and application of the brainstorming literature. First, brainstorming would appear to be as foreign to college students as it would to most others (including those conducting the studies). Secondly, brainstorming was designed to be used by adults working on real challenges within organizations. To what degree can results from undergraduate students be generalized to the target population of professional adults?

Unless the consumers of brainstorming research are limited to those who deal primarily with college students, the type of samples for future research should include adults working within organizations. There have been a few notable contributions in this regard (Basadur, Graen & Green, 1982; Basadur, Graen & Scandura, 1985; Basadur & Thompson, 1986; Ekvall, 1981; Ekvall & Parnes, 1989; Gryskiewicz, 1980a; Paulus, Larey & Ortega, 1995), but more work needs to be accomplished. Future brainstorming research should utilize samples for which it was primarily designed, as well as a variety of other age groups, so that important developmental differences can be explored.

### ***Evaluation of Outcomes***

In order to assess the productivity of brainstorming, some explicit measurement criteria are necessary. Although 21 different measures have been used in the 50 studies (see Table 3), by far the most pervasive criterion has been the quantity of ideas produced. Studies have often used quantity alone because of high correlations between quantity and quality (Diehl & Stroebe, 1987; Kaiser-Lee & Dzindolet, 1994; Parnes, 1961). Parnes and Meadow (1959) reported correlations ranging from .64 to .81

between total quantity and the number of “good” ideas. Good ideas were those that were unique (statistical infrequency: the degree to which the response deviated from the conventional use of the object) and of value (socially useful: the degree to which the response was judged to have social, economic, aesthetic, or other usefulness). The interrater reliabilities were .74 and .91 on the two tasks.

**Table 3.** *Evaluation Measures Utilized*

<u>Evaluation of Outcomes</u>	<u>Number of Times Used in the 50 Studies</u>
Quantity	32
Quality	15
Originality	10
Uniqueness	5
Enthusiasm	4
Fluency	4
Value	4
Satisfaction	3
Flexibility	3
Usefulness	2
Generality	2
Practicality	2
Interesting	1
Appropriate	1
Probability	1
Hitchhiked	1
Humorous	1
Novelty	1
Effectiveness	1
Orientation	1
Holistic	1

In only a few cases were real-life measurements attempted. Quantity of ideas alone may not be very important in real organizational problem solving. Usually, real problem-solving tasks call for the selection and implementation of high-quality ideas. Individuals or groups are rarely rewarded based on their ability solely to generate a high quantity of ideas.

There are many other important variables and factors upon which the productivity of group performance can be assessed. As Gryskiewicz (1984) stated, “I believe additional qualitative variables are necessary to clearly identify and evaluate the assets and liabilities of the CPS technologies” (p. 7).

Some research has focused on other variables such as subject satisfaction with the ideas generated. A recent study (Gallupe, Bastianutti & Cooper, 1991), not included in the 50 studies reviewed, compared satisfaction of interacting group members and nominal group members. Interacting members were more comfortable with the process, felt more motivated to generate quality ideas, felt they had greater opportunity to express their ideas, and felt they had more ideas than they actually expressed. These members were also more satisfied and confident in the quality of their ideas.

Sometimes the desired outcome for using group problem-solving tools is the benefit of team building and involvement. In the adult professional world, brainstorming is

often applied to encourage participation and acceptance of ideas. Some research supports the idea that training in creative problem solving effects small-group communication behaviors (Firestien, 1990; Firestien & McGowan, 1988).

Others have found that additional criteria are important within organizations. Sutton and Hargadon (1996) found that working in real brainstorming groups enhances participants ability to do competent work in the future. They believe that the experience contributes to the participants' growth and personal well-being. Surely, these findings are important when considering the utilization of groups within the organizational setting.

It is important to look at quality apart from the factor of quantity. Average quality of ideas from a group following the guidelines for brainstorming would be expected to be lower than a non-brainstorming group. It might be more appropriate to examine the actual number of better quality ideas rather than average quality. The reason for this is that individuals in brainstorming groups are deferring their judgment until another phase of problem solving. Since they are asked to create many, varied, and unusual ideas, there will be more ideas produced that may be very silly and foolish. In reality, no group member would select and implement one of these options without first subjecting it to development and evaluation. If researchers include these silly ideas in their overall measure of quality, the average quality would likely be lower for brainstorming groups.

In addition, although most of the evaluation of outcomes from brainstorming research has been focused on the final quantity of ideas, a fruitful line of inquiry would be on understanding when, during the activity of brainstorming, the highly valuable ideas occur. Some research indicated that more of the better ideas came later in a brainstorming session. This has been identified as the extended effort principle of idea generation (Basadur & Thompson, 1986; Parnes, 1961; Paulus & Dzindolet, 1993) and would add a new dimension for future brainstorming evaluation research.

The evaluation of brainstorming productivity provided the sixth major issue examined by this review of research. The following section will identify implications and discussion based on this review.

## **Implications and Discussion**

It appears that the prevailing paradigm for brainstorming research focuses more on comparing individual and group productivity, ignoring the original stated purpose, and design of the tool. On the basis of this review of 50 empirical studies and related literature, Stein's (1975) assessment that brainstorming may be the most researched and least understood creative thinking technique may be warranted. Future brainstorming research should deal more effectively with the six major issues and numerous testable questions identified and examined through this review.

At best, the prevailing paradigm for brainstorming research illustrates the importance of dealing with the complexities of working with real groups in future studies. We simply must move beyond the nominal versus real group issue toward actual testing of the group tools and conditions or modifications which improve the productivity of

group idea generation. Improving the productivity of real working groups continues to be a major issue for those who work within organizations around the world. Using nominal groups for comparison removes most of the trip wires and moderator variables ever present in real working groups.

The second major issue raised by this review was the importance of examining the impact of facilitation during brainstorming sessions. One of the most effective ways to overcome social loafing, free riding, evaluation apprehension, uniformity pressure and production blocking is to utilize a facilitator during brainstorming sessions. It is the role of the trained facilitator to observe the interaction patterns, energy, and evenness of participation during the brainstorming session and provide an appropriate array of idea-stimulating techniques to support the general guidelines.

Very frequently, individual and group tools are utilized within the same idea-generation session. Current best practice clearly provides for a blending of idea-stimulating techniques and these can even be placed, to some extent, in a contingency model for quantitatively and qualitatively different types of ideative productivity (Gryskiewicz, 1987). Although there is sufficient literature to provide guidance and descriptions of the facilitative role, there has not been a large amount of empirical investigation in this area (Clawson, Bostrom & Anson, 1993). Better understanding of the impact of the facilitative role on the productivity of brainstorming groups offers a robust area for future research. Investigations within this area could also have a profound influence on future practice.

The third issue for this review was the kind and amount of training the groups received. Current research is lacking in terms of helping researchers or practitioners improve their understanding of best-practice conditions under which to study or develop idea-generating behavior. Future brainstorming research needs to consider the role of the amount and kind of training provided on the tool itself and on idea-generating skills and strategies in general. Future brainstorming research should stimulate both productive learning and application.

The remaining issues included the tasks and samples utilized, as well as the measures or criteria for evaluating the outcomes of the brainstorming sessions. The overall "reality level" of most previous brainstorming research is fairly low. Most studies used untrained students working in artificial groups on relatively meaningless tasks with little or no concern for measuring anything but sheer quantity of ideas produced. Future brainstorming research would be more applicable to the population for whom it was intended if it included real groups working on important tasks which really mattered, and could be assessed upon a variety of authentic measures (Treffinger, 1994).

On the basis of this review organized around six major issues, it appears that there are many fruitful implications for future brainstorming research. As with any other line of research, an improved understanding and conceptualization of the core constructs under investigation will enable more productive application of improved statistical methodologies and research approaches. Following advice derived from erroneous conclusions, that brainstorming is not an effective idea-generating tool, would be analogous to "...throwing the baby out with the bath water." The challenge is knowing which is which. Opportunities lie ahead to improve our understanding of how and when to best apply brainstorming in what kinds of situations in order to get

specific kinds of results.

Brainstorming was introduced more than 50 years ago in an effort to help groups generate ideas. Osborn's aim was not merely the generation of ideas, but to encourage everyone to better apply their imaginations to challenges and opportunities. Brainstorming must be kept in perspective. There are dozens of other CPS tools which have never been the subject of as much empirical research as brainstorming.

Other areas like idea evaluation as well as the learning and use of various other CPS tools should be investigated. CPS itself has continued to be developed and improved since its origin by Osborn (Basadur, 1994; Isaksen & Dorval, 1993). These development efforts have been stimulated by research and scientific interests, as well as practical and applied concerns for answering the demand for improving the creative productivity of individuals, groups, and organizations.

If we are to make any serious progress in developing the creative problem solving skills and abilities so necessary for the future, we will need to conduct a much broader kind of inquiry armed with an improved conceptual framework.

## References

- Bales, R. F. (1985). The new field theory in social psychology. International Journal of Small Group Research, *1*, 1-18.
- Basadur, M. (1994). Simplex®: A flight to creativity. Buffalo, NY: Creative Education Foundation Press.
- Basadur, M., Graen, G. B., & Green, S. G. (1982). Training in creative problem solving: Effects on ideation and problem finding and solving in an industrial research organization. Organizational Behavior and Human Performance, *30*, 41-70.
- Basadur, M., Graen, G. B., & Scandura, T. A. (1985). Training effects on attitudes toward divergent thinking among manufacturing engineers. Journal of Applied Psychology, *71* (4), 612-617.
- Basadur, M., & Thompson, R. (1986). Usefulness of the ideation principle of extended effort in real world professional and managerial creative problem solving. Journal of Creative Behavior, *20* (1), 23-34.
- Beaton, E. M. (1990). A critical review and analysis of empirical brainstorming research. Unpublished masters project, Center for Studies in Creativity, State University College at Buffalo.
- Bayless, O. L. (1967). An alternative for problem solving discussion. Journal of Communication, *17*, 188-197.
- Bennis, W. & Biederman, P. W. (1997). Organizing genius: The secrets of creative collaboration. NY: Addison-Wesley Publishing Co.
- Bottger, P. C., & Yetton, P. W. (1987). Improving group performance by training in individual problem solving. Journal of Applied Psychology, *72*, 651-657.
- Bouchard, T. J., Jr. (1972). Training, motivation, and personality as determinants of the effectiveness of brainstorming groups and individuals. Journal of Applied Psychology, *56* (4), 324-331.
- Bouchard, T. J., Jr., Barsaloux, J., & Drauden, G. (1974). Brainstorming procedure, group size and sex as determinants of the problem-solving effectiveness of groups and individuals. Journal of Applied Psychology, *59* (2), 135-138.
- Bouchard, T. J., Jr., & Hare, M. (1970). Size, performance, and potential in brainstorming groups. Journal of Applied Psychology, *54* (1), 51-55.
- Brillhart, J. K., & Jochem, L. M. (1964). Effects of different patterns on outcomes of problem-solving discussion. Journal of Applied Psychology, *48* (3), 175-179.
- Buyer, L. S. (1988). Creative problem solving: a comparison of performance under different instructions. Journal of Creative Behavior, *22* (1), 55-61.

- Camacho, L. M. & Paulus, P. B. (1995). The role of social anxiousness in group brainstorming. Journal of Personality and Social Psychology, 68, 1071-1080.
- Campbell, J. P. (1968). Individual versus group problem solving in an industrial sample. Journal of Applied Psychology, 52 (3), 205-210.
- Clawson, V. K., Bostrom, R. P., & Anson, R. (1993). The role of the facilitator in computer-supported meetings. Small Group Research, 24, 547-565.
- Cohen, D., Whitmyre, J. W., & Funk, W. H. (1960). Effect of group cohesiveness and training upon creative thinking. Journal of Applied Psychology, 44 (5), 319-322.
- Collaros, P., A., & Anderson, L. R. (1969). Effect of perceived expertness upon creativity of members of brainstorming groups. Journal of Applied Psychology, 53 (2), 159-163.
- Comadena, M. E. (1984). Brainstorming groups: Ambiguity tolerance, communication apprehension, task attraction, and individual productivity. Small Group Behavior, 15 (2), 251-264.
- de Bono, E. (1992). Serious creativity: Using the power of lateral thinking to create new ideas. New York: Harper Business.
- Dennis, A. R., & Valacich, J. S. (1993). Computer brainstorms: More heads are better than one. Journal of Applied Psychology, 78, 531-537.
- Dennis, A. R., & Valacich, J. S. (1994). Group, sub-group and nominal group idea generation: New rules for a new media? Journal of Management, 20, 723-736.
- Diehl, M., & Stroebe, W. (1987). Productivity loss in brainstorming groups: Toward the solution of a riddle. Journal of Personality and Social Psychology, 53 (3), 497-509.
- Diehl, M. & Stroebe, W. (1991). Productivity loss in idea-generating groups: Tracking down the blocking effect. Journal of Personality and Social Psychology, 61, 392-403.
- Dillon, P. C., Graham, W. K., & Aidells, A. L. (1972). Brainstorming on a "hot" problem: Effects of training and practice on individual and group performance. Journal of Applied Psychology, 56 (6), 487-490.
- Dunnette, M. D., Campbell, J., & Jaastad, K. (1963). The effect of group participation on brainstorming effectiveness for two industrial samples. Journal of Applied Psychology, 47 (1), 30-37.
- Ekvall, G. (1981). Creative problem solving methods in product development - A comparative study. Stockholm, Sweden: The Swedish Council for Management and Organizational Behavior - Farådet.
- Ekvall, G. & Parnes, S. J. (1989). Creative problem solving methods in product development - A second experiment. Creativity and Innovation Yearbook, 2, 122-142.
- Fernald, L. W. & Nickolenko, P. (1993). The creative process: Its use and extent of formalization by corporations. Journal of Creative Behavior, 27(3), 214-220.
- Firestien, R. L. (1990). Effects of creative problem solving training on communication behaviors in small groups. Small Group Research, 21, 507-521.
- Firestien, R. L. & McGowan, R. (1988). Creative problem solving and communication behavior in small groups. Creativity Research Journal, 1, 106-114.
- Firestien, R. L., & Treffinger, D. J. (1983). Creative problem solving: Guidelines and resources for effective facilitation. Gifted Child Today, 6, 2-10.
- Firestien, R. L., & Treffinger, D. J. (1989). Guidelines for effective facilitation of creative problem-solving (part 3 of 3). Gifted Child Today, 12 (6), 40-44.
- Galegher, J., Kraut, R. E., & Egido, C. (1990). Intellectual teamwork: Social and technological foundations of cooperative work. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Gallupe, R. B., Bastianutti, L. M. & Cooper, W. H. (1991). Unblocking brainstorms. Journal of Applied Psychology, 76, 137-142.
- Gallupe, R. B. & Cooper, W. H. (1993). Brainstorming Electronically. Sloan Management Review, 35, 27-36.
- Gallupe, R. B., Cooper, W. H., Grisé, M. L., & Bastianutti, L. M. (1994). Blocking electronic brainstorms. Journal of Applied Psychology, 79, 77-86.
- Gallupe, R. B., Dennis, A. R., Cooper, W. H., Valacich, J. S., Bastianutti, L. M., Nunamaker, J. F. (1992). Electronic brainstorming and group size. Academy of Management Journal, 35, 350-369.
- Gerlach, V. S., Schutz, R. E., Baker, R. L., & Mazer, G. E. (1964). Effects of variations in test directions on

originality test response. Journal of Educational Psychology, 55 (2), 79-83.

Goethals, G. R. & Darley, J. M. (1987). Social comparison theory: Self-evaluation and group life. In B. Mullen & G. R. Goethals (Eds.), Theories of group behavior (pp. 21-48). NY: Springer-Verlag.

Goodman, P. S., and Associates (1986). Designing effective work groups. San Francisco, CA: Jossey-Bass.

Graham, W. K. (1977). Acceptance of ideas generated through individual and group brainstorming. Journal of Social Psychology, 101, 231-234.

Graham, W. K., & Dillon, P. C. (1974). Creative supergroups: Group performance as a function of individual performance on brainstorming tasks. Journal of Social Psychology, 93, 101-105.

Green, T. B. (1975). An empirical analysis of nominal and interacting groups. Academy of Management Journal, 18, 63-73.

Gryskiewicz, S. S. (1980a). A study of creative problem solving techniques in group settings. Unpublished doctoral dissertation, University of London, London.

Gryskiewicz, S. S. (1980b). Creative problem solving: Are individuals still superior to groups? Some creative thinking about brainstorming. Planned Innovation, 3, 3-5.

Gryskiewicz, S. S. (1984). Uniformity pressure revisited: An evaluation of three creative problem-solving techniques in an industrial setting. Paper presented at the ninety-second Annual Convention of the American Psychological Association, Toronto, Canada.

Gryskiewicz, S. S. (1987). Predictable creativity. In S. G. Isaksen, (Ed.), Frontiers in creativity research, Beyond the basics (pp. 305-313). Buffalo, NY: Bearly Limited.

Gurman, E. (1968). Creativity as a function of orientation and group participation. Psychological Reports, 22, 471-478.

Gustafson, D. H., Ramesh, K. S., Delbecq, A., & Walster, G. W. (1973). A comparative study of differences in subjective likelihood estimates made by individuals, interacting groups, Delphi groups, and nominal groups. Organizational Behavior and Human Performance, 9, 280-291.

Hackman, J. R. (1990). Groups that work and those that don't: Creating conditions for effective teamwork. San Francisco, CA: Jossey-Bass.

Hackman, J. R., & Morris, C. G. (1975). Group tasks, group interaction process, and group performance effectiveness: A review and proposed integration. In L. Berkowitz (Ed.), Advances in experimental social psychology (Volume 8 - pp. 45-99). NY: Academic Press.

Harari, O., & Graham, W. K. (1975). Tasks and task consequences as factors in individual and group brainstorming. Journal of Social Psychology, 95, 61-65.

Hare, A. P. (1976). Handbook of small group research (Second edition - Individual versus group - Chapter 14, pp. 307-329). NY: The Free Press.

Harkins, S. G. (1987). Social loafing and social facilitation. Journal of Experimental Social Psychology, 23, 1-18.

Harkins, S. G., Latané, B., & Williams, K. (1980). Social loafing: Allocating effort or taking it easy? Journal of Experimental Social Psychology, 16, 457-465.

Harkins, S. G., & Petty, R. E. (1982). Effects of task difficulty and task uniqueness on social loafing. Journal of Personality and Social Psychology, 43 (6), 1214-1229.

Hymans, N. B., & Graham, W. K. (1984). Effects of goal setting and initiative on individual brainstorming. The Journal of Social Psychology, 123, 283-284.

Isaksen, S. G. (1983). Toward a model for the facilitation of creative problem solving. Journal of Creative Behavior, 17, 18-30.

Isaksen, S. G. (1988). Innovative problem solving in groups: new methods and research opportunities. In Y. Ijiri & R. L. Kuhn (Eds.), New directions in creative and innovative management (pp. 145-168). Cambridge, MA: Ballinger Publishing.

Isaksen, S. G. (1992). Facilitating creative problem solving groups. In S. S. Gryskiewicz & D. A. Hills (Eds.), Readings in innovation (pp. 99-135). Greensboro, North Carolina: Center for Creative Leadership.

Isaksen, S. G. & Dorval, K. B. (1993). Changing views of creative problem solving: Over 40 years of continuous improvement. International Creativity Network Newsletter, 3, 1-4.

Isaksen, S. G., & Dorval, K. B. (1996). Facilitating creative problem solving. Sarasota, FL: Center for Creative Learning.

- Isaksen, S. G., Dorval, K. B. & Treffinger, D. J. (1994). Creative approaches to problem solving. Dubuque, IA: Kendall/Hunt Publishing Co.
- Isaksen, S. G., Dorval, K. B. & Treffinger, D. J. (1998). Toolbox for creative problem solving: Basic tools and resources. Buffalo, NY: Creative Problem Solving Group - Buffalo.
- Isaksen, S. G. & Treffinger, D. J. (1985). Creative problem solving: The basic course. Buffalo, NY: Bearly Limited.
- Isaksen, S. G. & Treffinger, D. J. (1991). Creative learning and problem solving. In A. L. Costa (Ed.), Developing minds - Programs for teaching thinking: Volume Two (pp. 89-93). Alexandria, VA: Association for Supervision and Curriculum Development.
- Jablin, F. M. (1981). Cultivating imagination: Factors that enhance and inhibit creativity in brainstorming groups. Human Communication Research, 7 (3), 245-258.
- Jablin, F. M., & Seibold, D. R. (1978). Implications for problem-solving groups of empirical research on 'brainstorming': A critical review of the literature. The Southern Speech Communication Journal, 43, 327-356.
- Jablin, F. M., Seibold, D. R., & Sorenson, R. L. (1977). Potential inhibitory effects of group participation on brainstorming performance. Central States Speech Journal, 28, 113-121.
- Jablin, F. M., & Sussman, L. (1978). An exploration of communication and productivity in real brainstorming groups. Human Communication Research, 4 (4), 229-337.
- Janis, I. L., & Mann, L. (1977). Decision making: A psychological analysis of conflict, choice and commitment. NY: The Free Press.
- Kaiser-Lee, P., & Dzindolet, M. T. (1994). The effect of cultural heterogeneity on performance and communication satisfaction in small task groups. Poster presentation at the 6th annual American Psychological Society convention, Washington, DC.
- Karau, S. J. & Williams, K. D. (1993). Social loafing: A meta-analytic review and theoretical integration, Journal of Personality and Social Psychology, 65(4), 681-706.
- Katzenbach, J. R. (1998). Teams at the top: Unleashing the potential of both teams and individual leaders. Cambridge, MA: Harvard Business School Press.
- Katzenbach, J. R. & Smith, D. K. (1992). The wisdom of teams: Creating the high-performance organization. Cambridge, MA: Harvard Business School Press.
- Kerr, N. L. (1983). Motivation losses in small groups: A social dilemma analysis. Journal of Personality and Social Psychology, 45, 819-828.
- Kerr, N. L. & Bruun, S. E. (1983). Dispensability of member effort and group motivation losses: Free-rider effects. Journal of Personality and Social Psychology, 44, 78-94.
- Kinlaw, D. C. (1993). Team-managed facilitation: Critical skills for developing self-sufficient teams. San Diego, CA: Pfeiffer & Company.
- Kinlaw, D. C. (1996). Facilitation skills: Create your own training program. NY: McGraw-Hill.
- Lamm, J. & Trommsdorff, G. (1973). Group versus individual performance on tasks requiring ideational proficiency (brainstorming): A review. European Journal of Social Psychology, 3, 361-388.
- Larson, C. E. & LaFasto, F. M. J. (1989). Teamwork: What must go right - what can go wrong. Newbury Park, CA: SAGE Publications.
- Lattané, B., Williams, K., & Harkins, S. (1979). Many hands make light work: The causes and consequences of social loafing. Journal of Personality and Social Psychology, 37, 822-832.
- Leclef, F. (1994). 132 managers talk about creativity consultancy. In H. Geschka, S. Moger, & T. Rickards (Eds.), Creativity and Innovation: The power of synergy (pp. 45-49). Darmstadt, Germany: Geschka & Partner Unternehmensberatung.
- Lingren, H. C. & Lingren, F. (1965). Creativity, brainstorming, and orneriness: a cross-cultural study. The Journal of Social Psychology, 67, 23-30.
- Lorge, I., & Solomon, H. (1955). Two models of groups behavior in the solution of eureka-type problems. Psychometrika, 20, 139-148.
- Lorge, I., & Solomon, H. (1959). Individual performance and group performance in problem solving related to group size and previous exposure to the problem. Journal of Psychology, 48, 107-114.

- Lorge, I., & Solomon, H. (1960). Group and individual performance in problem solving related to previous exposure to problem, level of aspiration, and group size. Behavioral Science, *5*, 28-38.
- Madsen, D. B., & Finger, J. R., Jr. (1978). Comparison of a written feedback procedure, group brainstorming, and individual brainstorming. Journal of Applied Psychology, *63* (1), 120-123.
- Maginn, B. K., & Harris, R. J. (1980). Effects of anticipated evaluation on individual brainstorming performance. Journal of Applied Psychology, *65* (2), 219-225.
- Maier, N. R. (1970). Problem solving and creativity: In individuals and groups. Belmont, CA: Brooks/Cole.
- Mann, R. D. (1959). A review of the relationships between personality and performance in small groups. Psychological Bulletin, *56*, 241-270.
- McFadzean, E. (1997). Improving group productivity with group support systems and creative problem solving techniques. Creativity and Innovation Management, *6*, 218-225.
- McGovern, F. (1991). Teaming up. USAir Magazine, *13*, 41-49.
- McLagan, P., & Nel, C. (1995). Participation: New governance for the workplace and the world. San Francisco, CA: Berrett-Koehler Publishers.
- Meadow, A., & Parnes, S. J. (1959). Evaluation of training in creative problem solving. Journal of Applied Psychology, *43* (3), 189-194.
- Meadow, A., Parnes, S. J., & Reese, H. (1959). Influences of brainstorming instructions and problem sequence on a creative problem solving test. Journal of Applied Psychology, *43* (6), 413-416.
- Milton, G. A. (1965). Enthusiasm vs. effectiveness in group and individual problem solving. Psychological Reports, *16*, 1197-1201.
- Mullen, B., Johnson, C. & Salas, E. (1991). Productivity loss in brainstorming groups: A meta-analytic integration. Basic and Applied Psychology, *12*, 3-23.
- Nečka, E. (1984). The effectiveness of synectics and brainstorming as conditioned by socio-emotional climate and type of problem. Polish Psychological Bulletin, *15* (1), 41-50.
- Nečka, E. (1985). The use of analogy in creative problem solving. Polish Psychological Bulletin, *16* (4), 245-255.
- Nunamaker, J. F., Applegate, L. M. & Konsynski, B. R. (1987). Facilitating group creativity: Experience with a group decision support system. Journal of Management Information Systems, *3*, 6-19.
- Offner, A. K., Kramer, T. J. & Winter, J. P. (1996). The effects of facilitation, recording, and pauses on group brainstorming. Small Group Research, *27*, 283-298.
- Olson, (1965). The logic of collective action: Public goods and the theory of groups. Cambridge, MA: Harvard University Press.
- Orbell, J., & Dawes, R. (1981). Social dilemmas. In G. Stephenson & H. H. Davis (Eds.), Progress in applied social psychology (Vol. 1, pp. 37-65). NY: Wiley.
- Osborn, A. F. (1942). How to think up. NY: McGraw-Hill.
- Osborn, A. F. (1948). Your creative power: How to use imagination. NY: Charles Scribner's Sons.
- Osborn, A. F. (1952a). Wake up your mind: 101 ways to develop creativeness. NY: Charles Scribner's Sons.
- Osborn, A. F. (1952b). How to become more creative: 101 rewarding ways to develop your potential talent. NY: Charles Scribner's Sons.
- Osborn, A. F. (1953). Applied Imagination: Principles and procedures of creative thinking. NY: Charles Scribner's Sons.
- Osborn, A. F. (1957). Applied Imagination: Principles and procedures of creative thinking (Revised edition). NY: Charles Scribner's Sons.
- Osborn, A. F. (1963). Applied Imagination: Principles and procedures of creative problem solving (Third edition). NY: Charles Scribner's Sons.
- Osborn, A. F. (1967). Applied Imagination: Principles and procedures of creative problem solving (Third revised edition). NY: Charles Scribner's Sons.
- Oxley, N. L., Dzindolet, M. T., & Paulus, P. B. (1996). The effects of facilitators on the performance of brainstorming groups. Journal of Social Behavior and Personality, *11*, 633-646.
- Parloff, M. B., & Handlon, J. H. (1964). The influence of criticalness on creative problem solving in dyads.

Psychiatry, 52, 117-122.

Parnes, S. J. (1961). Effects of extended effort in creative problem solving. Journal of Educational Psychology, 52 (3), 117-122.

Parnes, S. J. (1963). The deferment-judgment principle: A clarification of the literature. Psychological Reports, 12, 521-522.

Parnes, S. J. (1985). A facilitating style of leadership. Buffalo, NY: Bearly Limited.

Parnes, S. J. (Ed.). (1992). Sourcebook for creative problem solving. Buffalo, NY: Creative Education Press.

Parnes, S. J. (1997). Optimize the magic of your mind. Buffalo, NY: Bearly Limited.

Parnes, S. J., & Meadow, A. (1959). Effects of "brainstorming" instructions on creative problem solving by trained and untrained subjects. Journal of Educational Psychology, 50 (4), 171-176.

Parnes, S. J., Noller, R. B. & Biondi, A. M. (1977). Guide to creative action. New York: Scribners.

Paulus, P. B., Brown, V., & Ortega, A. H. (1995). Group creativity. In R. E. Purser & A. Montuori (Eds.), Social creativity in organizations. Cresskill, NJ: Hampton Press.

Paulus, P. B., & Dzindolet, M. T. (1993). Social influence processes in group brainstorming. Journal of Personality and Social Psychology, 64, 575- 586.

Paulus, P. B., Larey, T. S., & Ortega, A. H. (1995). Performance and perceptions of brainstormers in an organizational setting. Basic and Applied Social Psychology, 17, 249-265.

Paulus, P. B., Larey, T. S., Putnam, V. L., Leggett, K. L., & Roland, E. J. (1996). Social influence processes in computer brainstorming. Basic and Applied Social Psychology, 18, 3-14.

Price, K. H. (1985). Problem-solving strategies: A comparison by problem-solving phases. Group & Organization Studies, 10 (3), 278-299.

Rees, F. (1991). How to lead work teams: Facilitation. San Diego, CA: Pfeiffer & Company.

Renzulli, J. S., Owen, S. V., & Callahan, C. M. (1974). Fluency, flexibility, and originality as a function of group size. Journal of Creative Behavior, 8 (2), 107-113.

Rickards, T., Aldridge, S. & Gaston, K. (1988). Factors affecting brainstorming: Towards the development of diagnostic tools for assessment of creative performance. Research and Development Management, 18 (4), 309-320.

Rosenthal, R. (1984). Meta-analytic procedures for social research (Volume 6 in the Applied Social Research Methods Series). Beverly Hills, CA: SAGE Publications.

Rotter, G. S., & Portugal, S. M. (1969). Group and individual effects in problem solving. Journal of Applied Psychology, 53, 338-341.

Rowatt, W. C., Nesselroade, K. P. Beggan, J. K., & Allison, S. T. (1997). Perceptions of brainstorming in groups: The quality over quantity hypothesis. Journal of Creative Behavior, 31, 131-150.

Ruback, R. B., Dabbs, J. M., & Hopper, C. H. (1984). The process of brainstorming: an analysis with individual and group vocal parameters. Journal of Personality and Social Psychology, 47 (3), 558-567.

Seta, J. J., Seta, C. E., & Donaldson, S. (1991). The impact of comparison processes on coactors' frustration and willingness to expend effort. Personality and Social Psychology Bulletin, 17, 560-568.

Shepperd, J. A. (1993). Productivity loss in performance groups: A motivation analysis. Psychological Bulletin, 113, 67-81.

Smith, B. L. (1993). Interpersonal behaviors that damage the productivity of creative problem-solving groups. Journal of Creative Behavior, 27 (3), 171-187.

Stein, M. I. (1975). Stimulating creativity: Group procedures (Volume two). NY: Academic Press.

Street, W. R. (1974). Brainstorming by individuals, coacting and interacting groups. Journal of Applied Psychology, 59 (4), 433-436.

Stroebe, W. R., Diehl, M., & Abakoumkin, G. (1992). The illusion of group effectivity. Personality and Social Psychology Bulletin, 18, 643-650.

Sutton, R. I., & Hargadon, A. (1996). Brainstorming in context: Effectiveness in a product design firm. Administrative Science Quarterly, 41, 685-718.

Taylor, D. W. & McNemar, O. W. (1955). Problem solving and thinking. Annual review of psychology, 6, 455-482.

- Taylor, D. W., Berry, P. C., & Block, C. H. (1958). Does group participation when using brainstorming facilitate or inhibit creative thinking? Administrative Science Quarterly, *6*, 22-47.
- Torrance, E. P. (1970). Influence of dyadic interaction on creativity functioning. Psychological Reports, *26*, 391-394.
- Treffinger, D. J. (1994). Productive thinking: Toward authentic instruction and assessment. The Journal of Secondary Gifted Education, *30*, 30-37.
- Treffinger, D. J., & Firestien, R. L. (1989, July). Guidelines for effective facilitation of creative problem solving (1st of 3 parts). Gifted Child Today, *12* (4), 35-39.
- Treffinger, D. J. & Isaksen, S. G. (1992) Creative problem solving: An introduction. Sarasota, FL: Center for Creative Learning, Inc.
- Turner, W. M. & Rains, J. D. (1965). Differential effects of "brainstorming" instructions upon high and low creative subjects. Psychological Reports, *17*, 753-754.
- Van de Ven, A., & Delbecq, A. L. (1971). Nominal versus interacting group processes for committee decision-making effectiveness. Academy of Management Journal, *14*, 203-212.
- Van de Ven, A., & Delbecq, A. L. (1974). The effectiveness of nominal, Delphi, and interacting group decision making processes. Academy of Management Journal, *17*, 605-621.
- VanGundy, A. B. (1992). Idea power: Techniques and resources to unleash the creativity in your organization. NY: AMACOM.
- Vroom, V. H. (1974). Decision making and the leadership process. Journal of Contemporary Business, *3*, 47-67.
- Vroom, V. H. & Yago, A. G. (1988). Managing participation: A critical dimension of leadership. Journal of Management Development, *7*, 32-42.
- Wallas, G. (1926). The art of thought. London, UK: Butler & Tanner, Ltd.
- Watson, W., Michaelsen, L. K. & Sharp, W. (1991). Member competence, group interaction, and group decision making: A longitudinal study. Journal of Applied Psychology, *76*, 803-809.
- Weisskopf-Joelson, E., & Eliseo, T. S. (1961). An experimental study of the effectiveness of brainstorming. Journal of Applied Psychology, *45* (1), 45-49.
- Williams, K. D., & Karau, S. J. (1991). Social loafing and social compensation: The effects of expectations of co-worker performance. Journal of Personality and Social Psychology, *61*, 570-581.
- Wolf, F. M. (1986). Meta-analysis: Quantitative methods for research synthesis (Paper 59 of the Quantitative applications in the social sciences series). Beverly Hills, CA: SAGE Publications.
- Zagona, S. V., Willis, J. E., & MacKinnon, W. J. (1966). Group effectiveness in creative problem-solving tasks: An examination of relevant variables. The Journal of Psychology, *62*, 11-137.
- Zander, A. (1985). The purposes of groups in organizations. San Francisco, CA: Jossey-Bass.