A Reexamination of Brainstorming Research: Implications for Research and Practice

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ABSTRACT

Brainstorming may be the best-known tool for group idea generation and is widely taught in gifted and talented programs. Many empirical studies have been conducted regarding the effectiveness of brainstorming, and they have provided useful insights into the salient barriers facing groups who use this tool. Although a great deal of this literature focuses on the limitations of brainstorming, the exploratory study included in this article sheds light on approaches that can enhance the value of this tool by examining the impact of the facilitator's role within group idea generation. Finally, this article outlines recommendations for teaching, learning, and applying brainstorming.

"The creative process does not end with an idea, it only starts with an idea."
—John Arnold

Creativity and productive thinking are stated goals of most programs designed for the gifted and talented (Feldhusen & Treffinger, 1985; Gowan, Khatena, & Torrance, 1979). Creative learning and creative problem solving are well established programming areas for those who provide differentiated, as well as regular classroom instruction (Costa, 2001; McGrane & Sternberg, 1992; Pfeiffer, 2003). Brainstorming has arguably become the most widely known and used (and, all too frequently, misused) term associated with creativity and creative problem solving.

A great deal of brainstorming research appears to narrowly focus on four "guidelines." This problem is compounded by an overwhelming focus on the question: Are individuals or groups more productive when brainstorming (Rickards, 1999)? Many who read this research are led to the misguided conclusion that brainstorming should not be used for group idea generation (Diehl & Stroebe, 1991; Nickerson, 1999).

The purposes of this article are to reexamine the empirical literature surrounding this group procedure and to offer some suggestions for improving this line of inquiry. We will discuss the results of an exploratory study that investigated the importance of the role of the group facilitator. This article will conclude with implications for those interested in teaching, learning, and applying brainstorming.

Background

Osborn (1953) outlined specific procedures for creative problem solving, including one tool he called brainstorming for the creative collaboration of groups. Osborn

PUTTING THE RESEARCH TO USE

The purpose of this article is to help educators appreciate the brainstorming procedure as a powerful and valuable addition to any learning program. Since brainstorming is a group procedure, teachers can respond to the necessity of helping groups work better together, jointly create solutions to complex problems, and create common support for implementation of those ideas.

Teachers can use the information presented here to design effective brainstorming sessions. Many critical researchers have discovered that brainstorming—limited simply to four basic rules—does in fact have limitations. This article reviews these limitations and explains how the entire brainstorming procedure mitigates these issues. Teachers can pursue the best practices included in this article to help them teach about brainstorming and to design effective brainstorming sessions.

(1953, 1963) outlined four guidelines for brainstorming: (a) criticism is ruled out—group members should defer judgment until after the session; (b) freewheeling is welcomed—because it is easier to tame down ideas, participants are encouraged to share their wild ideas; (c) quantity is wanted—the more ideas participants have, the better the chances they will have good ideas; and (d) combination and improvement are sought—participants should feel free to build on ideas from others. Beyond providing the four guidelines, Osborn outlined detailed procedures for making brainstorming work, including the preparation of the group, the task to be worked on, the climate for the session, and the role of the group leader.

Some studies were supportive of brainstorming. Meadow and Parnes (1959) compared trained subjects working in real groups using brainstorming to an alternative group approach calling for critical evaluation. Significantly more high-quality solutions were produced in the brainstorming condition. A number of other scholars have confirmed these results (Gerlach, Schutz, Baker, & Mazer, 1964; Parloff & Handlon, 1964; Price, 1985; Weisskopf-Joelson & Eliseo, 1961). Other proponents have expanded on these results (Brown & Paulus, 2002; Firestien & McCowan, 1988; Meadow, Parnes, & Reese, 1959; Parnes, 1961).

Taylor, Berry, and Block (1958) provided the first comparison between nominal and real brainstorming groups. Since nominal groups allow for individuals to work alone and then pool their results after the fact, they minimize any of the potential process losses of real interacting groups. By comparing real groups to nominal groups in this way, numerous studies have identified many of the possible barriers to productivity in brainstorming groups.

Barriers to Effective Brainstorming

Three major categories of barriers explain the improved performance of nominal groups over real groups. These are: the emergence of judgments during generation, members giving up on the group, and an inadequate structure of the interaction. We will review each of these below.

Applying Judgment Inappropriately

Numerous studies have pointed out the existence of uniformity pressure and evaluation apprehension in brainstorming groups. The productivity of brainstorming groups may be inhibited by fear of critical evaluation and the participants' desire to go along with the dominant pattern of idea generation. Some studies (Dunnette, Campbell, & Jaastad, 1963; Vroom, Grant, & Cotton, 1969) found that the lack of participation by those who were more influenced by the fear of evaluation allowed others (presumably less inhibited) to dominate the discussion, especially in the early phases of the session. Other studies (Camacho & Paulus, 1995; Diehl & Stroebe, 1987, 1991; Maginn & Harris, 1980) have confirmed that fear of evaluation inhibits the productive generation of ideas.

Cognitive inertia, which occurs when group members pursue the same line of thinking, has been identified in several studies (Bouchard, Barsaloux, & Drauden, 1974; Vroom et al., 1969). This notion is similar to cognitive uniformity, where individuals feel pressure to support and maintain the direction of a discussion and not stray too far from the current theme (Taylor et al., 1958).

Fear of being judged and pressure to stay within the bounds of existing options clearly have an inhibiting effect on the performance of groups when their task is generating many, varied, and unusual ideas. It also underscores the notion that there may be other significant factors that impact group performance.

Giving Up on the Group

Individuals give up on a group during brainstorming for a number of reasons. Studies have pointed out that free riding, social loafing, matching of effort, or the sucker effect can limit the productivity of real brainstorming groups (Henningsen, Cruz, & Miller, 2000; Kerr & Bruun, 1983). These barriers lower motivation and effort when individuals work collectively. When these barriers are present, the individual gives up on the group and synergy is minimized (Latané, Williams, & Harkins, 1979).

Karau and Williams (1993) defined social loafing as "the reduction in motivation and effort when individuals work collectively compared with when they work individually or coactively" (p. 681). Working coactively is when individuals work in the real or imagined presence of others, but their inputs are not combined with the inputs of others.

Social loafing has received a great deal of attention in the literature (e.g., Harkins, Latané, & Williams, 1980; Jackson & Williams, 1985; Paulus, 1983; Shepperd, 1993). Factors purported to explain social loafing include a lack of accountability and decreased influence.

Social loafing results when there is a loss of personal accountability for performance. Individuals are not as likely to be held personally accountable for the results (positive or negative) when working in a group. Typical behavior manifested by reduced accountability includes less focus on performance standards or greater reliance on an individual high performer in the group (Kerr & Bruun, 1983). Thus, people can "hide in the crowd" with less concern over being held personally accountable for (poor) group performance (Davis, 1969).

Social loafing may also be caused by the perception of decreased personal influence on results. Each individual member of a group has less influence or impact on the group, reducing the individual's contribution to the group's productivity (Ruback, Dabbs, & Hopper, 1984). Social loafing is more likely as the size of the group increases (Karau & Williams, 1993).

Matching of effort, or the "sucker effect," has also been found to increase the likelihood that members might give up on the group (Paulus & Dzindolet, 1993; Zalesny & Ford, 1990). Individuals working in groups may compare and match their performance with that of others in their group (Paulus, Brown, & Ortega, 1999; Seta, Seta, & Donaldson, 1991). Mulvey and Klein (1998) found that those who perceived that teammates were loafing lowered their own personal goals because they anticipated that others had done the same. To protect themselves from carrying the highest burden on the team, individuals may also lower their efforts so as to avoid being the sucker of the free riding of other members (Orbell & Dawes, 1981). This reduction of effort can occur even if group members only perceive loafing or if other group members offer excuses, justifications, apologies, or other defensive management strategies (Mulvey, Bowes-Sperry, & Klein, 1998).

A variety of intrapersonal factors may influence the commitment of individuals within groups. These may include various personality characteristics (Jablin & Seibold, 1978) and diversity of cognitive styles (Wheeler, 1995), as well as gender and cultural differences (Lamm & Trommsdorff, 1973). In addition, the kind and amount of time devoted to tasks may also influence individuals' decisions to give up on the group. If members of brainstorming groups are provided enough time and encouragement to extend their effort, they generate more and better ideas than groups lacking this time and effort (Basadur & Thompson, 1986; Parnes, 1961; Watson, Michaelsen, & Sharp, 1991). Zagona, Willis, and MacKinnon (1966) found that groups lacking the time to get to know each other did not take full advantage of the diverse knowledge of other members.

Giving up on the group can be caused by the quality of the interaction among group members. The failure to listen during group interaction (Jablin & Seibold, 1978), the mismanagement of time (Bouchard, 1972), and the ability of the group to keep judgment separate from idea generation (Osborn, 1953) can all affect the quality of the interaction.

The amount of training participants received to prepare for effective group interaction may also influence the degree to which individuals may give up on a group. Smith (1993) illustrated the impact of even brief training on group idea-generating performance. Groups receiving only 5 minutes of training on discounting (verbal or nonverbal criticism) and its effects on group ideation significantly outperformed untrained 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.

Members of brainstorming groups who perceive that other members are not pulling their own weight have lower satisfaction with the group and lower ultimate performance (Mulvey et al., 1998). Members rationalize their reduced effort by focusing on such factors as the inability to receive credit or blame for group performance, the fear of being "used" by other group members, and the increased difficulty of coordinating effort. Unless there is some group process intervention designed to mitigate these issues, suboptimal group performance will result.

Interacting Within a Limiting Process Structure

A third challenge facing real brainstorming groups is that the structure of the interaction can inhibit productivity. This is called production blocking, or the procedural mechanism effect. Production blocking refers to the impact of group process that encourages only one person to talk at a time (Bouchard & Hare, 1970; Diehl & Stroebe, 1987) or having only one person recording ideas at a flipchart (Mullen, Johnson, & Salas, 1991). The impact is that others are inhibited or prohibited from contributing during the time that someone else is talking or ideas are being recorded.

A prime contributor to production blocking is the lack of procedures that encourage simultaneous processing. Bouchard (1972) found significant differences on group productivity depending on such variables as idea

recording method (tape recorded vs. self-written), pre-session instructions, and group size.

This notion of manipulating recording methods was extended by Gallupe, Bastianutti, and Cooper (1991). They agreed with Osborn (1953) that group members do think of more ideas than they actually produce. Indeed, they suggested that this problem increases with groups of larger sizes (Cohen, Whitmyre, & Funk, 1960). Their hypothesis was that electronic methods might be effectively employed by groups to mitigate this factor. Nunamaker, Applegate, and Konsynski (1987) provided support for this notion.

In summary, inappropriately applying judgment, giving up on the group, and interacting within a limiting process structure represent barriers to group productivity that have been uncovered in a large portion of the research on group brainstorming.

Overcoming the Barriers

A great deal of brainstorming research has focused on determining the barriers to real-group productivity. Hackman (1987) urged researchers to shift their focus from productivity losses to productivity gains. Two promising areas for overcoming the barriers outlined above include the use of technology and facilitation.

The Use of Technology

One area of research designed to overcome the barriers outlined above includes Electronic Brainstorming (EBS), Group Support Systems (GSS), or Group Decision Support Systems (GDSS). This area has been explored by a number of researchers (Clawson, Bostrom, & Anson, 1993; Cooper, Gallupe, Pollard, & Cadsby, 1998; Dennis, Valacich, Connolly, & Wynne, 1996; Thompson & Coovert, 2002). While this emerging line of research offers important implications for overcoming barriers in real groups, this technology is not universally available in classrooms and organizations.

Instead of comparing real groups with nominal groups or individuals, EBS research compares real groups to virtual groups, linked via technology. Because the technology enables simultaneous participant interaction in real time and provides anonymity and protection from criticism, it is capable of mitigating some of the factors that have been found to reduce productivity in real group meetings (Hollingshead & McGrath, 1995).

EBS research has provided insights to help minimize production blocking and increase anonymity in order to reduce evaluation apprehension (Connolly, Jessup, & Valacich, 1990; Gallupe et al., 1991). The benefits of reducing this apprehension include: a wider variety of ideas, the identification of more new topics and ideas, and increased involvement and participation (Nunamaker, Briggs, Mittleman, Vogel, & Balthazard, 1997).

EBS research has focused on such issues as consensus and equality of influence (Zigurs & Dickson, 1990), the complexity and relevance of the task and group structure (Hollingshead & McGrath, 1995), quality of decisions (Bui & Sivasankaran, 1990; Dennis, Valacich, & Nunamaker, 1990), and the use of e-mail as opposed to face-to-face meetings (Eveland & Bikson, 1989; Finholt, Sproull & Kiesler, 1990).

Benbasat and Lim (1993) found that formal hierarchy appeared to reduce the benefits of using EBS. However, the negative effects of hierarchy in a real-group session had significantly greater impact, resulting in such things as extended meetings, fewer alternatives shared, reduced elaboration or flexibility in thinking, and generally lower satisfaction. EBS proved to be a much better medium when compared to real-group meetings, as it relates to these factors.

There are some difficulties surrounding the use of EBS. Hare (1976) points out that a group's ability to focus and decide is more difficult when a large number of ideas are available for review. EBS may also result in less overall participation (Daly, 1993) and more task-irrelevant communication (Weisband, 1992).

A number of questions surrounding the nature of the technology have also been raised. Nunamaker et al. (1997) discussed the difference between idea description fields that allow for short, concise answers and those that allow for more elaboration. The nature or design of the description field can affect the number of ideas generated, as well as the degree of detail and elaboration provided.

On the basis of this research, EBS can mitigate inappropriate judgment through anonymity and overcome many of the challenges of production blocking. While the use of technology does advance the effective use of groups, Nunamaker et al. (1997) concluded that technology does not replace the need for group leadership. In sharing some of the lessons they learned over 12 years of using group support systems, they stated that the use of technology " . . . can make a well-planned meeting better, and it can make a poorly planned meeting worse . . .

any tool is only as good as the artisan who wields it" (pp. 171–172).

The Use of Facilitators

Osborn (1953) defined the role of group leader, or facilitator, who would be responsible for a variety of activities before, during, and after the meeting. These responsibilities included reinforcing the guidelines and encouraging the even participation of all group members. In addition, the leader was responsible for identifying a variety of tools and structuring the interaction so that people would maintain their energy and ideas would be recorded quickly and accurately. These activities were designed to prepare group members for dealing both with the task at hand and with the process. In this way, group productivity would be enhanced, as many of the barriers to thinking would be managed or eliminated.

A few studies have examined the effects of using a trained facilitator to help manage the group interaction. Offner, Kramer, and Winter (1996) found that having a trained facilitator who managed the group interaction and recorded ideas significantly influenced idea production. They found that groups with a facilitator did better than those without one. The facilitated brainstorming groups matched the performance of nominal groups. Oxley, Dzindolet, and Paulus (1996) reported similar findings when studying the level of training of the facilitator. They found that the groups having the benefit of a highly trained facilitator outperformed nonfacilitated groups, as well as those helped by facilitators with less training. They concluded that groups with a highly trained facilitator may achieve the productivity of nominal groups without foregoing the advantages of interaction.

The prevailing paradigm of comparing real against nominal groups has led to an improved understanding of the salient barriers to brainstorming productivity and some technology-based strategies for overcoming them. It has not offered a great deal of additional insight for those who must function with face-to-face, bona fide groups (Putnam & Stohl, 1990, 1996) or work groups (Ford, 1999; Forsyth, 2000; Sundstrom, McIntyre, Halfhill, & Richards, 2000). This is important since real, diverse, and dispersed groups are increasingly doing so much of what goes on in the world. Sutton and Hargadon (1996) critiqued brainstorming research because, in large part, it uses participants who:

> (1) had no past or future task interdependence; (2) had no past or future social relationships; (3) didn't use the ideas generated; (4) lacked pertinent technical expertise; (5) lacked skills that complement other participants; (6) lacked expertise in doing brainstorming; and (7) lacked expertise in leading brainstorming sessions. (p. 4)

Although these limitations were identified on the basis of an inquiry within an industrial design firm, many could also be relevant to a classroom situation. For example, the productivity of brainstorming within a classroom can be enhanced if the students involved have learned and applied the skills associated with working effectively within groups.

Given the need for real group-to-group comparisons there is a need for research to obtain an improved understanding of additional procedures that impact productivity gains of real groups. The following exploratory study was conducted as an instructional exercise with an undergraduate humanities class within a public university college to reach that objective.

The Study

This exploration took place within the context of an instructional experience. The purpose of the instructional experience was to help the students discover some of the differences that might result from following different small-group idea-generating procedures. A discovery-oriented approach outlined by McCall and Bobko (1990) was followed. The study sought to demonstrate the difference a facilitator might make when working with small-group procedures, as well as to allow for a comparison of various procedures for idea generation.

Method

This exploratory study involved generating ideas for dealing with junk mail. The task was chosen for its familiarity and its realistic qualities. Participants were randomly divided into nine working groups, each assigned a specific procedure for generating ideas. Three groups were instructed to have a discussion: One of these was instructed to have a free discussion (Group 1), one was instructed to have a discussion aimed at producing 5–7 really good ideas (Group 2), and the third was instructed to come up with at least 20 ideas (Group 3).

The fourth and fifth groups were instructed to use Brainwriting (Geschka, Schaude, & Schlicksupp, 1975; Gryskiewicz, 1980). Brainwriting allows participants to write their own ideas down and to share them by exchang-

ing papers during the session, allowing both simultaneous processing and building on each other's ideas. In one of these two groups, a Brainwriting facilitator joined the group to help generate ideas (Group 4); in the other, the facilitator explained the tool and stimulated some ideas, but did not actually join the group in generating ideas or in modeling the use of the tool (Group 5).

The sixth group was instructed to generate ideas individually, but follow the guidelines for brainstorming (Group 6). This condition most closely resembled the nominal group approach taken in much of the empirical brainstorming research. The seventh group was instructed to work as a group and follow the guidelines for brainstorming (Group 7). This group most closely resembled the group brainstorming condition used in most of the empirical research.

The eighth group was instructed to work with a trained facilitator to come up with as many ideas as possible. The facilitator used brainstorming with Post-its® (Isaksen, Dorval, & Treffinger, 1998) and used some idea stimulators to help the group generate ideas (Group 8). Brainstorming with Post-its® allows each participant to record their own ideas simultaneously and then share them verbally with the group after which they are posted on a flipchart to encourage "hitch-hiking," or deliberately building on ideas offered by others in the group. The ninth group was instructed to work with a trained facilitator, who followed the same procedure as in Group 8, but also had someone in the group who took on the role of client (Group 9). The client had received facilitator training as well, but, in this situation, was asked to take on the role of owning the task, clarifying the problem, and answering questions, but not evaluating the ideas. The facilitator of this group briefed the participants on the social roles included in an idea-generating session (Isaksen, 1983).

Each of the four facilitators participating in the study had received extensive training in the facilitation of creative problem-solving approaches (Isaksen & Dorval, 2000; Isaksen, Dorval, & Treffinger, 2000; Parnes, Noller, & Biondi, 1977). The facilitators used their knowledge and skills to introduce the tools and prompt the group members to follow the guidelines, rather than following a detailed script.

Participants

The sample was an intact group of students who had a history of interaction. They received partial course credit for their involvement. The course included 82 registered undergraduate students. This particular course was chosen for the study due to the fact that it was a humanities elective and likely to draw a diverse group of students. Students were provided the option to participate in the experience or an alternative class exercise. Only 2 of the 82 students registered for the course elected to participate in the alternative exercise. Six students were absent for the exercise. The participants included 27 males and 48 females. The facilitator for the fourth group is included for a total of 75 participants in the study. Their average age was 24.4 years and spanned from 18 to 56. They came from a variety of major departments and included some students who had not declared a major.

Procedure

The exercise occurred within the last third of the semester. Students were given a one-page summary memo the week before the class in which they would actually be asked to generate ideas. They were provided with background, a description of the desired outcome for the work they would do, and an invitation to think about the challenge prior to the next class. The basic question outlined in the memo was, "What can we do about the increasing amount of junk mail?" The desired session outcome was described as, "I would like to have a variety of original ideas that help me deal more effectively with my junk mail." The specific problem statement used for all the groups was, "How to deal with junk mail?"

Students reported to class the following week and were randomly assigned a letter corresponding to the group within which they would work. Time was given for each of the students to go to their assigned room, and all groups started and stopped working within a 30-minute time limit. Observers were assigned to each of the five groups that were not assigned a facilitator.

The observers and the facilitators collected data, and a preliminary report of the gross fluency was reported to the class and used for instructional purposes. Later, the ideas were recorded from the flipcharts, forms, and sheets turned in by the participants. Ideas that were duplicated were subtracted from the gross number and net fluency was calculated.

Results

Table 1 shows the net fluency produced from each of the nine groups. The open-discussion group (Group 1) produced more ideas than either of the other two discus-

Table 1

Fluency Results Across Groups

Group #	Method Type	*n*	Gross Fluency	Redundant Ideas	Net Fluency
	Nonfacilitated Groups:				
1	Open discussion	9	29	1	28
2	Generate 5–7 ideas	8	7	0	7
3	Generate at least 20 ideas	8	21	0	21
6	Nominal group brainstorming	9	58	27	31
7	Brainstorm as a group	8	25	2	23
	Facilitated Groups:				
8	Brainstorm as a group with facilitator	8	132	22	110
9	Brainstorm as a group with facilitator and client	8	190	47	143
5	Brainwriting with facilitator	8	193	45	148
4	Brainwriting with facilitator also generating	9	332	64	268

sion groups that were assigned a quota. The discussion group given the 5–7 ideas quota (Group 2) actually produced 7 ideas, and the one given the quota of at least 20 (Group 3) produced 21, illustrating the importance of the specific instructions given to the group.

Consistent with previous research comparing nominal versus real groups, the group asked to follow the brainstorming guidelines but work individually (Group 6) produced more ideas than the real interacting group told to brainstorm as a group (Group 7). The group instructed to brainstorm on its own (Group 7) also produced fewer ideas than the group instructed to engage in a free discussion (Group 1). Group 6, the nominal group brainstorming condition, also outperformed all the discussion groups.

The four groups that utilized facilitators produced more ideas than the other five procedures by a ratio of more than 5:1. The group that included both a trained facilitator and a client produced more ideas than the group with only a trained facilitator. The client did not generate ideas, but seemed to have a positive effect on the group.

The Mann-Whitney U was computed to compare the facilitated against the nonfacilitated conditions (Sager & Baron, 1994). This nonparametric version of the two-group unpaired *t* test was applied given the number of observations within each category. When comparing the ranks between the two groups, significantly more ideas were generated by the facilitated groups ($z = -2.45$; $p < .02$) than those following instructions on their own.

The two groups using facilitated Brainwriting (Groups 4 and 5) performed better than the facilitated group brainstorming and all other procedures used in the study. The Brainwriting group that used the facilitator to generate ideas, as well as reinforce the brainstorming guidelines, generated more ideas than the Brainwriting group in which the facilitator only reinforced the guidelines and explained the tool.

Table 2 presents the gross fluency produced by each of the individuals in the nominal group brainstorming condition (Group 6). Looking more deeply into the comparison of the unfacilitated, nominal and real brainstorming groups, no individual generating alone outperformed the real brainstorming group. Further, the only group procedure that failed to produce more ideas than any individual within the nominal group was that of the discussion group that was asked to produce only 5–7 good ideas, a condition that deliberately introduced judgment.

Discussion

The results of many previous brainstorming studies have led some researchers to conclude that the use of group brainstorming is less effective than individuals generating ideas alone. The two groups in this study most closely resembling the typical comparison in much of the previous research were the nominal group (Group 6) and brainstorming as a group (Group 7), without the use of a facilitator. Consistent with previous research, the nominal group outperformed the real interacting group on

Table 2

Nominal Group Fluency Results

Participant	Number of Ideas
1	10
2	6
3	1
4	13
5	6
6	3
7	6
8	3
9	10
Total	58

fluency of ideas. However, no individual generating ideas alone outperformed the real interacting group. Further, the two real brainstorming groups using facilitators generated an average of 126.5 nonredundant ideas per group compared to 58 for the nominal group. The two real brainstorming groups using Brainwriting produced an average of 208 nonredundant ideas per group. This represents a 400–600% improvement on fluency, clearly illustrating the impact of having a trained facilitator.

Kramer, Fleming, and Mannis (2001) confirmed this finding. The results of their two experiments demonstrated that real brainstorming groups generate as many ideas as nominal groups, when assisted by a trained facilitator. Further, they argue for more focus on mechanisms to improve real-group brainstorming because of the numerous benefits derived from interacting groups (Dugosh, Paulus, Roland, & Yang, 2000). Fleming (2000) outlined these benefits as including the following: higher levels of coordinated effort in subsequent problem-solving stages; a clearer and common understanding of ideas generated and chosen for implementation; participants feeling more involved, responsible, and committed; and higher levels of satisfaction with the process.

From a practical perspective, this raises a question about the appropriateness of nominal groups being called groups at all. Katzenbach (1998) indicated that teams are made up of a small number of people with complementary skills who are committed to a common purpose and approach for which they hold themselves mutually accountable. Groups in name only lack most of these qualities. Further, nominal groups may lack the basic requirements, like face-to-face interaction, needed to provide insights about procedures and variables impacting real-group process gains.

The brainstorming group that was working without the benefit of a facilitator generated 23 nonredundant ideas, compared to an average of 167.25 ideas for the four facilitated idea-generation groups. Although, in principle, they were all using a similar real-group procedure, using a facilitator made an impressive 700% improvement. Brainstorming is not likely to have the benefits it was designed to produce without the assistance of a trained facilitator.

This exploratory study also reinforced the importance of how instructions are worded and provided to an idea-generating group. The group that was asked for 5–7 good ideas generated exactly 7 ideas. Similarly, the group asked to come up with at least 20 good ideas delivered 21. The group simply instructed to have an open discussion generated 29. Slight variations in the wording of instructions may have an effect on fluency, particularly for nonfacilitated groups.

Limitations

Although this study used randomly assigned membership to groups, as well as a common task and time frame, there were a number of limitations in its design and execution.

The problem itself, while being somewhat realistic, was not real. The participants were not especially motivated to solve the problem. The use of students in this type of study, while convenient, certainly was far less than ideal. In the future, it may be more appropriate to set up a situation using a real problem that engages the participants in a significant way. Using real-life professionals would improve the transferability of the findings to real-world applications.

The research design of this study did not allow for multiple groups using a similar approach, and this limits the strict interpretation and generalizability of its findings. The statistical analyses were also very limited in sophistication. Facilitators did not follow a prescribed or predetermined procedure, which limited the researchers' ability to determine precisely what the facilitators did to enhance performance.

This study measured only fluency of ideas as the criterion for effectiveness. Many researchers have called for additional criteria upon which to assess effectiveness

(Sutton & Hargadon, 1996). Future brainstorming research needs to consider criteria beyond fluency in order to better understand and validate the nature of process gains and to recognize that effectiveness is a multidimensional construct.

Implications and Applications

We have a number of core concerns regarding much of the previous research. First, the comparison of real groups to nominal groups sets up an unnecessary tension between individual and group idea-generating approaches. Osborn's (1953) original positioning of brainstorming included time for individual ideation before and after the session. His assertion was that brainstorming should not be seen as a replacement for individual ideation, but should be a supplement to individual effort. A great deal of previous research seems to miss this point.

A second major concern relates to the leadership role and responsibilities for managing a brainstorming session. Simply assembling a group and then telling them to brainstorm does not work and is entirely inconsistent with the practices suggested by Osborn. It is clear that the role of a trained group facilitator is central to having a successful brainstorming session. Osborn (1953) recommended that a leader of brainstorming sessions be well versed and trained in creative problem solving. Osborn saw the group leadership role in a brainstorming session as central to its success.

Isaksen & Dorval (2000) outlined the facilitator's role within creative problem-solving groups as including preparing the group, preparing the task, creating the environment, and facilitating process. Preparing the group involves ensuring that the participants are well aware of the task before they meet and that they are well versed in the brainstorming guidelines. Preparing the task means ensuring that it is well defined, that the expected outcomes are clear, and that the task is set up for ideation. Creating the environment involves establishing and maintaining a climate or patterns of behavior conducive to creative production. Finally, the facilitating process includes using generating and focusing tools appropriately, based on the observed quality of the interaction and the content of the ideation. By and large, a majority of the brainstorming research appears to ignore the importance of this facilitative leadership role.

A third concern is that brainstorming has been treated as an isolated event, rather than as a part of a larger process. As a group procedure, brainstorming was designed to be supplemented by individual ideation (before and after the group session) and by the use of a variety of other tools designed to enhance idea generation (i.e., idea-spurring questions, incubation). Brainstorming was introduced as one idea-generating tool within the entire creative problem-solving process.

Although much of the brainstorming research provides reinforcement of the barriers to group productivity, those authors who conclude that brainstorming has, at best, limited efficacy, have failed to appreciate the full scope of Osborn's (1953) proposition. Further, our experience and reading underscores the ubiquitous use of brainstorming in the real world (i.e., in nonlaboratory settings, amongst adult professionals, for the purpose of addressing real tasks) (Kerr & Tindale, 2004).

For those who have an interest in teaching brainstorming and in preparing students or colleagues to apply this group idea-generating tool, Table 3 outlines what Osborn (1953) described as best practice. As Table 3 illustrates, Osborn provided detailed suggestions for best practice before, during, and after a brainstorming session.

On the basis of this review of research, the exploratory study reported in this article, a review of Osborn's seminal work, and our own experience in applying brainstorming, we offer the following suggestions:

1. Put brainstorming in perspective. Brainstorming is only one part of a larger creative process. It is a good tool for groups of students who need to generate many, varied, and unique ideas. While there is an appropriate time for brainstorming, there is also a need for other complementary thinking processes and tools for analysis, judgment, and development of ideas. Since advertisers developed the term *brainstorming*, it is no surprise that it has found its way into broad, everyday use. The downside is that it has been used to describe everything from a heated debate to a group discussion, or even an excuse to dump work on someone else. The abuse of the term brainstorming has led to a general misunderstanding of its purpose and most effective use.

2. Be prepared. The success of the brainstorming effort depends on the effective execution of the group leader's role before, during, and after the session. Central to this is the responsibility to prepare the group, the task, and the environment for maximum productivity. The teacher, trainer, or facilitator must have an adequate level of train-

Table 3

Brainstorming Best Practices

Issues	Osborn's Original Recommendations
Before Brainstorming	
Prepare the group	"The . . . leader should be trained in advance for his function. Ideally he (the leader) should have taken a course in creative problem solving. At least, he should have assiduously studied problem-solving" (p. 172).
	Define roles and responsibilities (i.e., leadership, group members).
	Evaluate candidates for group membership based on the nature of the task, as well as self-starters, a mix of gender, styles, and content expertise.
	Group size should be between 5–7 participants for each facilitator.
	Invite participants and provide them with role definitions and key background information not less than 2 days before meeting. Include some examples of the type of ideas desired
	Provide training in the guidelines before the meeting, including a thorough orientation of participants unfamiliar with brainstorming.
	Provide for individual ideation before the session.
Prepare the task	"The leader's first job is to process the problem . . . definition of aim is often half the battle" (pp. 172–173).
	Provide a clearly focused problem statement (i.e., simple and specific, not complex or compound).
	Select tasks that require many, varied, and unusual ideas.
	Prepare a list of idea stimulating questions.
Prepare the environment	"The spirit of a brainstorming session is important" (p. 157).
	Ensure that, during the session, members have the same rank or level of power.
	Display and prepare to reinforce the guidelines.
	Prepare idea-spurring questions.
During Brainstorming	
Dealing with judgment	"Criticism is ruled out. Adverse judgment of ideas must be withheld until later" (p. 156).
	"Freewheeling is welcomed. The wilder the idea the better; it is easier to tame down than to think up" (p. 156).
	The session should start with an explanation of the task and a short Q&A.
	Explain guidelines in familiar language, using informal words.
	Enforce guidelines gently, but firmly.
Maintaining group commitment	"Combination and improvements are sought . . . participants should suggest how ideas of others can be turned into better ideas" (p. 156).
	Leaders should come prepared with ideas to submit during the dry periods.
	Extend effort by setting challenging quotas.
	Provide incubation breaks.
	The session lasts for 30–45 minutes.
	Reward all ideas with receptiveness.

Table 3 continued

Enhancing the process structure	"Quantity is wanted. The greater the number of ideas, the more the likelihood of useful ideas" (p. 156).
	Collect individual idea lists before the session starts.
	Each person makes notes of any ideas that they have until they can offer them.
	Have a recording secretary (or two if necessary).
	Have a "warm-up" session, with exercises that practice and reinforce key skills and principles.
	Tape record the session.
After Brainstorming	
Follow-through	"After brainstormers have slept on a problem, they sometimes generate the most valuable of all ideas" (p. 198).
	Combination, elaboration, etc. should be used to further develop ideas.
	Seek to reconsider the silliest ideas, and look for how they might be modified to create the best solution.
	Ask for afterthoughts—additional individual ideation.
	Provide feedback and thank you.
Evaluation	"It is usually wise to have the final evaluation done by those directly responsible for the problem" (p. 200).
	Use a separate session dedicated to evaluating ideas ("Ideas should always be screened and otherwise processed—with a smaller and different group" [p. 200]).
	Practical (e.g., pilot) testing is a most desirable method of verification.
Implementation	"It is for want of imagination in their application, rather than in their means of acquisition, that they (creative ideas) fail. The creative process does not end with an idea—it only starts with an idea" (p. 197).
	It takes 4 tons of ore to get 1 oz. of gold.

Note. The page references in this table are all from Osborn (1963).

ing, background, and experience in brainstorming and creative problem solving. Those teaching or training brainstorming should be aware that the impact of applying this tool is maximized by taking the necessary time to prepare in advance. Spontaneous brainstorming sessions may not yield as powerful an impact.

3. Have a robust tool kit. It is important that people have more than one tool in their tool kit. Brainstorming is best learned and applied in conjunction with other idea-generating tools and techniques. Further, a more complete creative process involves both critical and creative thinking, thus requiring the inclusion of critical thinking tools and techniques. Teachers should be aware that brainstorming is not the only tool available for idea generation and should expose their students in learning and applying a variety of thinking and problem-solving tools.

4. There is no substitute for experience. The best teachers and/or practitioners of brainstorming have extensive experience actually using the tool. This experience helps the user know when and how to apply brainstorming. These experiences have value when they are applied and debriefed for both out-of-context or warm-up tasks (i.e., uses for a brick) and real problems. Experience provides a deeper and more meaningful understanding of best-practice brainstorming. Teachers can apply brainstorming to a number of professional activities like curriculum planning, school administration, planning special events, etc., in order to acquire this experience. They can also take time to debrief the application of the tool with their students to encourage experiential learning.

5. Reinforce both individual and group ideation. Osborn designed brainstorming to supplement individual

ideation. He realized that there were many more sophisticated challenges facing real groups when they had to engage in ideation. Teachers, trainers, and facilitators need to provide adequate support and reinforcement for individual incubation and ideation, as well as creative collaboration by groups. It is important when planning any brainstorming session to allow time for individual ideation before or after its real-group application.

6. Emphasize benefits beyond fluency. For those teaching gifted students, the benefits of brainstorming go well beyond generating ideas. Brainstorming can result in improved coordination, better understanding of the ideas generated, and faster implementation of those ideas. In addition, individuals learn the importance of a climate conducive to creativity, the value of diverse thinking and problem-solving styles, and that creative thinking is enjoyable and powerful.

The purpose of this article was to examine the empirical brainstorming research, provide the results of an original exploratory study, and to outline implications and applications for effective brainstorming. Rather than throwing the baby out with the bathwater, we believe that the research can provide valuable insights for those who conduct future brainstorming research, as well as those interested in helping others learn and apply this valuable tool.

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The authors would like to thank Stanley S. Gryskiewicz, Sidney J. Parnes, Morris I. Stein, and Donald J. Treffinger for helpful comments on earlier drafts of this article. Also, many thanks are due to Eileen Beaton Colling and Matt Walters who provided technical assistance on this project.

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