Making Group Brainstorming More Effective: Recommendations From an Associative Memory Perspective

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Abstract

Much literature on group brainstorming has found it to be less effective than individual brainstorming. However, a cognitive perspective suggests that group brainstorming could be an effective technique for generating creative ideas. Computer simulations of an associative memory model of idea generation in groups suggest that groups have the potential to generate ideas that individuals brainstorming alone are less likely to generate. Exchanging ideas by means of writing or computers, alternating solitary and group brainstorming, and using heterogeneous groups appear to be useful approaches for enhancing group brainstorming.

Keywords

brainstorming; cognitive stimulation; groups; group creativity

There is a general belief in the efficacy of collaboration for projects involving innovation or problem solving (Bennis & Biederman, 1997; Sutton & Hargadon, 1996). Although there is some evidence for the effectiveness of collaborative science and teamwork (Paulus, 2000), the enthusiasm for collective work may not always be justified. Controlled studies of idea sharing in groups have shown that groups often overestimate their effectiveness (Paulus, Larey, & Ortega, 1995). Experiments comparing interactive brainstorming groups with sets of individuals who do not interact in performing the same task have found that groups generate fewer ideas and that group members exhibit reduced motivation and do not fully share unique information (e.g., Mullen, Johnson, & Salas, 1991). The strongest inhibitory effect of groups may be production blocking, which is a reduction in productivity due to the fact that group members must take turns in describing their ideas (Diehl & Stroebe, 1991).

One area in which these problems are most evident is the study of group creativity. Most research on creativity has examined individual creativity because it is typically seen as a personal trait or skill. However, today much creative work requires collaboration of people with diverse sets of knowledge and skills. How can such groups overcome the inevitable liabilities of group interaction to reach their creative potential? Is it possible to demonstrate that group interaction can lead to enhanced creativity? Examining these questions has been the aim of our program of re-

Published by Blackwell Publishing Inc.

search on the cognitive potential of brainstorming groups (Brown, Tumeo, Larey, & Paulus, 1998; Paulus & Brown, in press; Paulus, Dugosh, Dzindolet, Coskun, & Putman, 2002).

COGNITIVE BASES FOR IDEATIONAL CREATIVITY: A MODEL AND SUPPORTING EVIDENCE

Intuitively, the cognitive benefits of brainstorming in a group seem clear: People believe that they come up with ideas in a group that they would not have thought of on their own. The potential for mutual stimulation of ideas is one of the reasons for the popularity of group brainstorming.

Semantic Networks and an Associative Memory Model of Group Brainstorming

Clearly, the retrieval of relevant information from one's long-term conceptual memory is an important part of the brainstorming process because one cannot effectively brainstorm on a topic one knows nothing about. The concepts stored in long-term memory can be thought of as being associated in a semantic network in such a way that related concepts are more strongly connected than unrelated concepts and thus more likely to activate each other (e.g., Collins & Loftus, 1975). Thus, concepts that are more closely connected to those that are currently active should be more accessible than concepts that are less strongly connected to currently active ideas.

To use the semantic network representation as a basis for exploring group brainstorming, many details need to be specified. Rather than explicitly representing four, six, eight, or more semantic networks and the interactions among them—which would be cumbersome—our approach is to represent a brainstormer's knowledge of a given problem as a matrix of category transition probabilities: Each entry in this matrix represents the probability of generating one's next idea from the same category as the previous idea or from a different category (Brown et al., 1998).

A number of individual differences affecting brainstorming performance are captured by this framework. Fluency, or the amount of knowledge one has about the brainstorming problem, is represented by the probabilities in the main body of the matrix relative to the null category, which represents the likelihood of coming up with no idea in a given time interval. Convergent and divergent thinking styles also fit nicely into the framework. On the one hand, a convergent thinker is likely to stick with a category and explore it deeply before moving on to generate ideas from other categories. Thus, a convergent thinker is represented by a matrix with relatively high within-category transition probabilities. On the other hand, a divergent thinker is more likely to jump around between categories, and so is represented by a matrix with lower within-category transition probabilities (and correspondingly higher between-category transition probabilities). Because individual differences can be represented in this framework, the effects of different group compositions can be examined.

Accessibility

The property of the individual's semantic network that is crucial to determining the effectiveness of group brainstorming is category accessibility. People are generally unlikely to explore on their own relevant categories of ideas that have relatively weak connections with other categories in their personal semantic networks. Generation of ideas from these categories requires the spark of input from other brainstormers. For example, a student who lives on campus in a dormitory may be unlikely to generate ideas about parking when brainstorming on ways to improve the university. But if a student who commutes from off campus mentions parking, the dorm dweller may be able to come up with a few thoughts on the matter, perhaps recalling the parking difficulties his or her parents had when they visited. Simulations of the associative memory matrix model show that presenting a brainstormer with ideas from low-accessible categories not only increases the number of ideas generated from those categories, but also increases the total number of ideas generated overall, thus making the individual a more productive brainstormer. This prediction is supported by Leggett (1997), who studied individual brainstormers to evaluate how input of ideas in the absence of a group context (i.e., without inhibitory social influences) might provide cognitive stimulation. Participants listened to audiotapes containing ideas generated by participants who worked on the Thumbs Problem ("What would be the advantages and disadvantages of having an extra thumb on each hand?") in previous studies. Although all brainstormers benefited from being primed with relevant ideas, the amount of benefit depended on whether the ideas came from a category that was frequently or infrequently represented in the responses in the previous studies. Individuals who were primed with ideas from common categories obtained less benefit than those who were primed with ideas from unique categories. In other words, priming categories that were already likely to be utilized did not enhance performance as much as priming categories unlikely to be utilized by someone brainstorming on his or her own.

Attention

Individuals will be influenced by other group members to the extent that they pay attention to those other members' ideas. In the framework of the model, attention is represented as the probability that an individual group member uses the current speaker's idea as the basis for generating his or her next idea (as opposed to simply continuing his or her own internal train of thought).

Simulations predict that, in general, the more attention each individual pays to fellow group members, the better the performance of the group. Conversely, the more each individual's attention is distracted from the ideas of others, perhaps by concern for the social aspects of group brainstorming, the more the performance of the group declines. In particular, the more one attends to fellow brainstormers, the more one is likely to be primed to consider ideas from one's own low-accessible categories. In fact, the model predicts that, in general, if it were not for production blocking, the number of ideas generated by each group member would increase (at least up to a point) as group size increases (Brown et al., 1998).

One way to enhance the effects of attention on brainstorming performance is to instruct brainstormers that at the end of the brainstorming session they will be asked to recall the ideas that were presented during the session. Without memorization instructions, participants may be more likely to focus on the generation of their own ideas and to some extent ignore the ideas being presented by others. Interestingly, the effectiveness of memory instructions appears to be mixed. When participants are listening to audiotapes or exchanging ideas by computer, instructions to memorize facilitate idea generation (Dugosh, Paulus, Roland, & Yang, 2000). However, when participants are asked to exchange written ideas in a round-robin format (Paulus & Yang, 2000), memory instructions inhibit performance. Because the instructions to read the ideas as they are passed from person to person may already ensure that participants attend to the ideas, instructions to memorize may simply add an unnecessary additional processing demand and impede the brainstorming effort.

ENHANCING GROUP BRAINSTORMING

The goal of creating circumstances that optimize group performance requires maximizing the benefits of cognitive facilitation while at the same time minimizing the inhibitory processes that reduce group productivity. We have studied three brainstorming procedures that appear promising for theoretical reasons, and that have garnered some empirical support. These are combining group and solitary brainstorming, having group brainstormers interact by writing instead of speaking ("brainwriting"), and using networked computers on which individuals type their ideas and read the ideas of others (electronic brainstorming).

Individual and Group Brainstorming

At face value, the goal of maximizing the benefits of group exchange while minimizing inhibitory group processes suggests literally combining group and individual brainstorming. Of course, a person cannot brainstorm alone while at the same time brainstorming in a group. But one can alternate group and solitary idea-generation sessions. Preliminary data from our laboratory show that brainstorming in a group before brainstorming alone on the same topic produces more ideas over the course of the two sessions than does brainstorming alone in the first session and then brainstorming in a group the following session (Leggett, Putman, Roland, & Paulus, 1996).

Model simulations make clear the mechanisms that produce this advantage for the group-solitary sequence. The cognitive facilitation that occurs in the group session carries over into the solitary session, during which the brainstormer continues generating ideas without being hindered by production blocking. This effect shows up as a large "productivity spike" for solitary brainstormers in the second session in both model simulations and empirical studies. This order effect should be particularly strong when the initial group consists of heterogeneous members whose knowledge of the task differs. Simulations also indicate that a solitary brainstormer whose idea generation takes place following a group session is likely to sample more categories from the brainstorming topic than a similar brainstormer working in two solitary sessions. This suggests that the group-solitary sequence has an advantage over and above possible increases in overall productivity.

Brainwriting

Another way to take advantage of group priming effects while reducing production blocking would be to have group members interact by writing and reading rather than speaking and listening. This does not seem to be a technique that is often attempted. Perhaps people are so used to communicating orally when they are face to face that researchers do not consider the alternatives. In a study of group brainwriting (Paulus & Yang, 2000), group members wrote their ideas on a piece of paper and passed them on to the next group member, who read the ideas, added his or her own ideas, and passed the paper on. These interactive groups of brainwriters outproduced sets of equal numbers of writers who did not interact in performing the task. This result may be the first laboratory example of face-to-face interactive groups outperforming an equal number of solitary brainstormers.

Although model simulations support the observation that interactive brainwriters can outperform an equal number of solitary brainwriters (Paulus & Brown, in press), the simulation results are complex in some interesting ways. First, simulations predict that interactive brainwriting is not universally superior to individual brainwriting, but is most effective for heterogeneous groups whose members have differing knowledge of the brainstorming problem. Second, up to a point, performance of simulated brainwriting groups improves as the group members pay increasing attention to the written ideas, but performance decreases when attention to the written ideas becomes excessive. Obviously, brainwriters who do not read any of the ideas that are passed along to them will not benefit from the thoughts of their fellow brainwriters. Brainwriters who attend predominantly to the ideas of others will benefit from them to some extent, but not as greatly as those who optimally balance the two goals of attending to the ideas of others and following their own internal train of thought.

Electronic Brainstorming

The effectiveness of brainwriting suggests that using computers for exchanging ideas might be another useful way of tapping the creative potential of groups. Using computers, individuals can be exposed to a broad range of ideas without the verbal "traffic jams" that are problematic for face-to-face groups. In fact, because production blocking is greatly reduced, the larger the group the better—larger groups will increase one's exposure to a broad range of ideas. One of the most consistent findings in the electronic-brainstorming literature is that the benefits are most evident for groups of eight or more (Dennis & Williams, in press).

Unfortunately, it is also easier to ignore the inputs of others in the electronic format than in face-to-face situations. Instructing individuals to attend carefully to ideas shared electronically (e.g., because of an impending memory test) increases the impact of the shared information (Dugosh et al., 2000). Although electronic brainstormers do not have to apply extensive intellectual resources to try to remember the shared ideas because they are available on the computer, for large groups the number of available ideas can become rather overwhelming. It may be important to provide an opportunity for individuals to continue processing the ideas after the interactive session in order to gain full associative advantage of the shared information. The benefits of idea sharing in electronic groups are in fact most evident if individuals are provided such a solitary session after group interaction.

CONCLUSIONS

It is clear that unstructured groups left to their own devices will not be very effective in developing creative ideas. However, a cognitive perspective points to methods that can be used so that group exchange of ideas enhances idea generation. Groups of individuals with diverse sets of knowledge are most likely to benefit from the social exchange of ideas. Although face-to-face interaction is seen as a natural modality for group interaction, using writing or computers can enhance the exchange of ideas. The interaction should be structured to ensure careful attention to the shared ideas. Alternating between individual and group ideation is helpful because it allows for careful reflection on and processing of shared ideas.

There are still a number of significant empirical gaps that need to be addressed. Given that much group exchange consists of verbal interaction in face-to-face groups, studies need to determine the specific extent to which the performance of these groups can be enhanced by using insights from the associative memory perspective. In particular, it will be important to demonstrate that groups that contain members with diverse knowledge bases can effectively use this knowledge interactively for creative purposes. There are also no controlled studies of creativity in groups or teams in organizations outside the laboratory, so that it is not possible to draw definitive conclusions about the effectiveness of groups in the real world. Because group interaction can be a source of social and cognitive interference as well as social and cognitive stimulation, one of the main theoretical challenges will be to integrate the cognitive and social perspectives of group brainstorming. A careful delineation of how these processes interact will be of great benefit to practitioners.

Recommended Reading

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Note

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