Individual and Group Brainstorming: Does the Question Matter?

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Abstract

The goal of this research was to test whether the kind of question that is used to prompt brainstorming differentially affects individual and group idea generation performance. More specifically, it was examined if prompts that require brainstormers to generate alternate uses for common objects (e.g., other uses for cars) foster more benefits from collaborative ideation than prompts to generate improvements for an object, place, or process (e.g., ways to improve cars). These hypotheses were tested in two experiments using electronic idea exchanges. In Experiment 1, individuals generated ideas about either alternate uses or potential improvements for cars, SUVs, or vans. In Experiment 2, participants brainstormed in response to one of these two prompts in either an interactive group setting (exchanging ideas with two others) or individually (no idea sharing). The results of both experiments showed that alternate uses and improvements prompts indeed differentially affected ideational performance in terms of both idea quantity and quality. The results were also consistent with the well documented “process loss” on the improvements prompt, but the gap between interacting and nominal groups was closed on the alternate uses prompt. Implications for research and practice are discussed.

Keywords: brainstorming; creativity; group performance; idea generation
Innovation is the key to success for many of today’s businesses and organizations. However, all innovations begin with an idea. Thus, the first and critical step in the study of innovation is to uncover how creative ideas are derived. The importance of creative ideation is reflected in the very definition of creativity by scholars as the generation of novel and useful ideas, or more specifically as ideas that are uncommon, remote and clever, but also fitting and appropriate (e.g., Amabile, 1982; Finke, Ward, & Smith, 1992; Mayer, 1999). A popular technique to generate creative ideas is brainstorming, and it has received a lot of attention in creativity research.

In contrast to the variety of available divergent thinking tests (Guilford, 1968; Torrance, 1962, 2008; Wallach & Kogan, 1965) and differences among them (Acar & Runco, 2014, 2017; Christensen, Guilford, & Wilson, 1957; Hass & Beaty, 2018; Runco, Abdulla, Paek, Al-Jasim, & Alsuwaidi, 2016), only three types of questions (prompts) have generally been used in research on individual and group brainstorming: (1) improvements to an object, place, or process, such as ways to improve a university (e.g., Barki & Pinsonneault, 2001; Baruah & Paulus, 2008; De Dreu, Baas, & Nijstad, 2008), (2) consequences of hypothetical scenarios, such as advantages and disadvantages associated with having an extra thumb (e.g., Camacho & Paulus, 1995; Dugosh, Paulus, Roland, & Yang, 2000), and (3) alternate uses for a common household object, such as novel uses for a paperclip (e.g., Friedman, Fishbach, Forster, & Werth, 2003; Paulus & Yang, 2000). These three question types have been generally assumed to be equivalent as stimuli in the group brainstorming literature; however, the goal of the present research is to challenge this assumption, focusing on inherent differences between alternate uses and improvements prompts that may impact the opportunity to avoid process loss and reap the benefits of cognitive stimulation that can result from collaboration and idea sharing.
Alternate Uses Prompts

How a brainstorming prompt is posed can affect performance (Almeida, Prieto Prieto, Ferrando, Oliveira, & Ferrándiz, 2008; Runco & Dow, 2004). Two specific characteristics of alternate uses prompts are considered here. First, because the objective of the alternate uses task is to come up with various novel uses or ideas, such as novel uses for a paper clip, each response requires the generation of new ideas, presumably through the combination of remote and previously unrelated concepts (cf. Mednick, 1962). Thus, many solutions to alternate uses problems are unlikely to be fully formed in an individual’s long-term memory prior to the brainstorming session. This first characteristic will be referred to as low idea pre-formation. A related characteristic of alternate uses brainstorming prompts is that the generation of ideas involves overcoming functional fixedness, which refers to the difficulty of thinking of an object as having a function other than the one shaped by our prior knowledge about and experience with the object (Chrysikou, Motyka, Yang, & Thompson-Schill, 2016; Duncker, 1945; George & Wiley, in press; Glucksberg & Weisberg, 1966; Wiley, 1998; Wu, Cheng, Ip, & McBride-Chang, 2005). When brainstormers try to generate multiple new uses for an everyday object, they may experience mental blocks from thinking about traditional uses that can lead to impasse. In other words, an individual working alone may quickly become stuck and unable to come up with a new idea.

Both the low idea pre-formation and functional fixedness characteristics of the alternate uses questions can result in fixation and have consequences for individual brainstorming performance. Ideas may be generated at a relatively slow rate for two reasons. First, according to associative network or spreading activation theories of semantic memory (Collins & Loftus, 1975; Mednick, 1962), more closely related and typically co-occurring concepts will receive the
most activation and will have a greater probability of being retrieved from long-term memory than less closely related concepts. Creating new combinations of seemingly unrelated concepts, the defining characteristic of alternate uses prompts, may be a challenging, slow process.

Second, functional fixedness is difficult to overcome because a certain degree of restructuring, or change in the initial problem representation is required (e.g., Adamson, 1952; Dominowski & Dallob, 1995; Duncker, 1945). As a result, individuals may experience difficulty coming up with remote combinations of ideas and escaping their own fixation.

**Improvements Prompts**

In contrast to alternate uses prompts, questions that prompt participants to consider ways to improve a place, object, or an organization (improvements prompts), such as ways to improve one’s university, may differ in both idea pre-formation and the likelihood of difficulties resulting from functional fixedness. Undergraduate students, who are the typical participants in brainstorming research studies, may have already spent time already thinking about potential improvements to their university or to common objects. As a result, for improvements questions, many candidate solutions may be available in long-term memory (i.e. they are high in idea pre-formation) and need to simply be accessed and retrieved rather than generated (Madore, Jing, & Schacter, 2016; Runco & Acar, 2010). With these prompts, it may be less necessary to generate solutions using novel combinations of concepts and features. Further, solvers can base their improvements on their current knowledge about objects, meaning they do not need to restructure their understanding or overcome fixation due to prior knowledge to generate solutions for improvements prompts. Both high idea pre-formation and low likelihood of functional fixedness on the improvements brainstorming questions should lead to relatively less difficulty in generating solutions (less fixation). Thus, the following was predicted:
Hypothesis 1: Alternate uses and improvements brainstorming questions are not equivalent and will differentially impact idea generation performance.

Hypothesis 2: Individuals will experience more fixation on the alternate uses than improvements prompts.

Process Loss in Group Brainstorming

Brainstorming is often performed in groups in hopes that idea sharing will lead to more successful problem solving or innovation (Goldenberg, Larson, & Wiley, 2013; Goldenberg, & Wiley, 2011; Jarosz, Goldenberg, & Wiley, 2017; Osborn, 1963; Paulus & Brown, 2003). However, decades of empirical research on brainstorming since the initial study by Taylor, Berry, and Block (1958) point to the ineffectiveness of small group brainstorming relative to individual creative ideation – interacting groups typically come up with fewer ideas than an equal number of independently working individuals (nominal groups) whose products are combined to represent an expected baseline for group productivity (for reviews, see Larson, 2010 and Mullen, Johnson & Salas, 1991). Several factors have been identified to contribute to this so called “process loss” (Steiner, 1972), including the need to take speaking turns (Diehl & Stroebe, 1987; 1991), fixation on others’ ideas (Jansson & Smith, 1991; Smith, 2003), fear of being judged negatively by others (Camacho & Paulus, 1995; Diehl & Stroebe, 1987), and social loafing in groups (Harkins, 1987; Karau & Williams, 1993). Despite this grim picture of group performance, brainstorming researchers continue to search for the conditions that would reduce or eliminate process loss factors and allow the creative potential of groups to be realized.

Does Reduction in Process Loss and Cognitive Stimulation Depend on the Prompt?

Despite theoretical accounts that suggest that group brainstorming should lead to cognitive stimulation (Brown, Tumeo, Larey, & Paulus, 1998; Nijstad & Stroebe, 2006; Nijstad,
Diehl, & Stroebe, 2003; Paulus & Brown, 2003; Paulus & Yang, 2000), synergy (Larson, 2010), or process gain (Steiner, 1972), as noted above, few empirical studies have been able to demonstrate group advantages, and most studies find evidence for process loss. One exception is the widely cited study by Paulus and Yang (2000) that presented participants with the question of alternate uses for a paperclip. Importantly, Paulus and Yang (2000) found that their interacting groups came up with 40% more ideas than their nominal groups, a truly atypical result. Therefore, it is possible that one the reasons contributing to the high productivity of interacting groups in this study was the use of an alternate uses question.

The low rate of idea pre-formation and high rate of functional fixedness experienced on alternate uses prompts by individual brainstormers may impact opportunities for benefits in a group setting. Exposure to others’ ideas can provide external stimulation that may help individuals to overcome fixation imposed by alternate uses prompts. This idea is also consistent with suggestions made by others that group advantages should occur toward the end of the brainstorming session when idea generation rates naturally begin to decline (Dennis et al., 2005). Evidence shows that when people brainstorm alone, their per-minute idea generation rates gradually decline as the session progresses (e.g., Kohn & Smith, 2010). Building on this idea, Dennis et al. (2005) suggested that because it becomes increasingly difficult with time to keep generating new solutions, only then do individuals benefit from external stimulation by others’ ideas. In contrast to the alternate uses prompts, lower likelihood of fixation on the improvements brainstorming prompts leaves less opportunity for cognitive stimulation in a group setting. Moreover, fixating on others’ ideas may also result in lower idea variety (Kohn & Smith, 2010). This could decrease the number of ideas that groups generate. Therefore, the following prediction was tested:
Hypothesis 3: The improvements prompt will result in typical “process loss” from working in a group, while the alternate uses prompt will balance out the negative and positive aspects of group interaction.

The hypotheses were tested using an electronic brainstorming format (EBS) instead of face-to-face brainstorming. EBS is a form of virtual team communication (Nemiro, 2002) in which individuals record ideas and exchange them with others on a computer interface, using instant messaging technology, such as AOL or Google Talk (Dennis, Valacich, & Nunamaker, 1990). EBS was chosen for the present studies to create conditions similar to those that have been found to produce the best group results in the literature (i.e. Paulus & Yang, 2000). It is proposed that just like brainwriting that was used by Paulus and Yang (2000), EBS reduces production blocking that arises from turn-taking in face-to-face brainstorming (e.g., Dennis & Valacich, 1993; 1994; Dennis & Williams, 2005). In EBS, group members are able to type ideas concurrently, and thus, do not need to coordinate turn-taking to contribute ideas to the group, maximizing efficiency compared to traditional, oral brainstorming. EBS groups tend to perform as well as nominal groups when the number of high quality responses or average idea quality is considered (DeRosa, Smith, & Hantula, 2007), and in very large groups they produce more ideas than nominal groups.

Experiment 1

To provide initial empirical evidence of the differences between the alternate uses and improvements prompts predicted in Hypotheses 1 and 2 a study of individual brainstorming was conducted. To be consistent across the two experiments, the individuals in this study also used an EBS interface to collect responses.
Method

Participants and Design

Eighty-seven undergraduate college students from a public Midwestern university participated in the study in exchange for Introduction to Psychology course credit. The sample self-reported being 18 to 30 years old, with an average age of 19, and being 64% female and 36% male. The sample identified as 36% Asian, 30% Latinx, 24% White/Caucasian, 5% Black/African American, and 5% as other. Participants were randomly assigned to brainstorm individually in response to either the alternate uses (n = 49) or improvements prompt (n = 38).

Procedure

The experimenter greeted the participants and asked them to sign the agreement to participate. Next, the experimenter explained the brainstorming task to them as a group (with up to four people at a time) in the common area of the laboratory space. Every participant received a printed copy of instructions and was asked to follow along as the experimenter read them out loud. First, background information about brainstorming and the four brainstorming rules were given (Osborn, 1963): avoid self-criticism, focus on quantity, aim for unusual, remote solutions, and include idea combinations and improvements. Next, the idea recording procedure was explained. To record responses, each participant would independently type his or her ideas on a computer using the Google Talk instant messaging tool. Participants would see only their own typed ideas in the chat window, which would scroll after five visible lines. Additionally, they were asked to press “enter” after typing each idea to submit it, to use short, simple phrases, and not to worry about spelling or grammar. Finally, the brainstorming topic was given. Following these instructions, participants moved to separate computer rooms where they brainstormed
alone for 20 minutes about uses for cars, SUVs, or vans other than for transportation (alternative uses prompt) or about potential improvements to these vehicles (improvements prompt).

Following the brainstorming session, participants filled out a questionnaire that assessed their perceptions of the brainstorming session and general demographic information. Two items served as a subjective index of the extent of fixation experienced while brainstorming: (1) “I often felt like I was “stuck” while brainstorming” and (2) “Some of my earlier ideas got in the way of generating new, later ideas.” One item was geared toward gauging idea pre-formation: “I have thought about/considered improvements/other uses for cars, SUVs, and/or vans before this experiment.” An additional item assessed perceived difficulty: “It was difficult for me to keep generating new, additional ideas.” A five-point Strongly Disagree to Strongly Agree response scale was used for all items.

Coding

A set of dependent variables was computed for each individual. First, all responses were screened for redundancy. This resulted in a total of 220 non-redundant responses to the improvements prompt and 168 non-redundant responses to the alternate uses prompt. The number of non-redundant responses mentioned by each individual was used the measure of idea quantity. Idea quantity is the most commonly used index of brainstorming performance (e.g., Baruah & Paulus, 2008; Camacho & Paulus, 1995; Dennis & Valacich, 1993; Nemeth, Brown, & Rogers, 2001).

In addition, two measures of idea quality were computed: number of highly rated ideas and number of semantic categories sampled. The number of highly rated ideas was computed using a subjective assessment technique recommended by Silvia and colleagues (2008). According to this holistic approach to creativity ratings, a “highly creative” response is defined
as one that is uncommon, remote, and clever, yet still fitting and appropriate. Twenty-nine undergraduate psychology students were instructed to use this conceptualization of creativity to rate all non-redundant responses using a 5-point scale, with 1 = not all creative and 5 = very creative. Fifteen students rated 220 non-redundant responses to the improvements prompt, and fourteen students rated 168 non-redundant responses to the alternate uses prompt. A creativity score for each idea was computed by averaging the ratings. Ideas that received an average creativity score above the midpoint of the scale (higher than 3.00) across raters were considered high in creativity. The number of highly rated ideas was computed for each participant and served as one metric of idea quality.

As a second measure of idea quality, the number of task-relevant semantic categories sampled by each participant was computed (e.g., De Dreu et al., 2008; Nijstad et al., 2002; Goldenberg et al., 2013), similar to measures of ideational flexibility in divergent thinking tests (e.g., Guilford, 1968; Torrance, 1972). Appendix A lists the set of semantic categories that was used for each prompt. These categories were derived by first screening the ideas generated by participants in both experiments by the principal investigator and two research assistants. The tentative category lists were discussed by the research team to create a list of 29 non-redundant categories for each prompt. Each response was scored according to this category system, after which the total number of sampled categories was computed for each participant. Interrater agreement for this measure was high with an intraclass correlation coefficient (ICC) above .80.

Results

The means, standard deviations, $t$, $p$-values, and effect sizes for all dependent variables described below are reported in Table 1.

*Self-report measures of perceived fixation, prior ideation, and difficulty*
As shown in Table 1, those who brainstormed in response to the alternate uses prompt reported being stuck more often and experienced more interference from their own earlier-generated ideas when compared to those who brainstormed in response to the improvements prompt. In addition, consistent with the argument that ideas for improvements questions are at least partially formed in long-term memory, participants in the improvements condition reported having thought more about the question prior to the study than participants in the alternate uses condition. Interestingly, no difference was found between the improvements and alternate uses prompts in terms of perceived task difficulty, ruling out the alternative explanation of the improvements questions simply being easier for brainstormers.

**Idea Quantity**

Idea quantity was computed by counting the total number of non-redundant responses each person generated. As shown in Table 1, the results revealed no differences in average number of ideas generated by each individual between the alternate uses and improvements prompts.

**Idea Quality**

*Number of Highly Rated Ideas.* The number of highly rated ideas was computed for each participant. As shown in Table 1, the analyses revealed that the alternate uses prompt led to a lower number of responses rated as highly creative compared to the improvements prompt.

*Number of Semantic Categories.* To assess variety and flexibility of ideas, the number of task-relevant semantic categories sampled by each participant was computed. As shown in Table 1, the results of the Analysis of Variance (ANOVA) showed no difference in the number of semantic categories between the alternate uses and improvements prompts.

**Discussion**
The results of the first experiment provide initial empirical support for the idea that alternate uses and improvements prompts differentially affect performance, supporting *Hypothesis 1*. Self-report data lent support to *Hypothesis 2* predicting that alternate uses prompts may be more fixating for individuals than improvements prompts. This is consistent with the suggestion that alternate uses prompts may provide more of an opportunity for improvement in group settings than will improvements prompts.

**Experiment 2**

The main goal of this study was to test the prediction that exposure to others’ ideas in a real group setting will be more beneficial when given the alternate uses than the improvements prompts (*Hypothesis 3*). As in Experiment 1, participants brainstormed in response to either alternate uses or improvements prompts, but did so either individually or in interactive groups of three. There was no idea sharing in the individual condition, while in the interacting group condition, participants were able to read each other’s responses. This experiment allowed for the traditional interacting-nominal group comparison.

In addition, one limitation of Experiment 1 was the use of a subjective measure of idea quality that relied on the judgments of a group of raters (Benedek, Mühlmann, Jauk, & Neubauer, 2013; Plucker, Qian, & Wang, 2011; Runco & Acar, 2019). To address this issue, a more objective measure of idea quality (number of original ideas) was used in place of subjective ratings in Experiment 2. The second measure of idea quality (number of semantic categories) and the measure of idea quantity remained the same as in Experiment 1.

**Method**

*Participants and Design*
Two hundred and seventy undergraduate college students from the same university as in Experiment 1 participated in exchange for course credit. The sample reported being 72% female and 27% male, aged from 17 to 30 years old, with an average age of 19. The sample reported identifying as 33% Asian, 29% White/Caucasian, 25% Latinx, 6% Black/African American, 1% as Native American/Alaskan Native, 1% as Hawaiian/Pacific Islander, and 5% other.

This study employed a 2 question (alternate uses, improvements) x 2 setting (nominal group, interacting group) between-subjects factorial design. Participants were randomly assigned to brainstorm for 20 minutes either on the alternate uses or improvements prompt from Experiment 1. They were asked to do so in one of two settings. In the nominal group condition, they simply typed their ideas on a computer individually. In the interacting group condition, three same-gender participants typed and exchanged their ideas with each other. In both conditions, ideas were typed into an instant messaging tool.

**Procedure**

The experimenter greeted the participants and asked them to sign the agreement to participate. Next, the experimenter explained the brainstorming task to the participants as a group in the common area of the laboratory space. The same explanation was given as in Experiment 1, including background information on brainstorming, brainstorming rules, and EBS procedure. Groups and individuals generated ideas either on other uses for cars, SUVs, and/or vans or on improvements to these vehicles. Every participant received a printed copy of the instructions and was asked to follow along as the experimenter read them out loud.

After answering any remaining questions, the participants were placed in separate rooms and began the brainstorming activity. In the individual condition, the list of ideas visible in the Google Talk window contained only the participant’s own ideas. In the group condition, this list
contained all members’ ideas. As in Experiment 1, after five ideas, the list started to scroll so that only the most recent five lines were visible on the computer window screen in either condition.

The final questionnaire asked participants to rate their enjoyment of the task on a 1 to 5 scale. This item was designed to gauge participants’ impressions of working with others, as prior research suggests that people enjoy brainstorming in groups (reviewed in Larson, 2010).

Coding

For this experiment, measures of performance were computed at the group level. Nominal groups were created by combining all of the ideas generated by successive sets of three participants who had brainstormed individually on the same prompt (Taylor et al., 1958). The same coding process was used as developed in Experiment 1, and each group’s ideas were scored for the total number of non-redundant responses as an index of idea quantity.

Two measures of quality were also computed: number of highly original ideas and number of semantic categories. The category coding was the same as in Experiment 1, and the ICC was above .85. In contrast to Experiment 1 which used subjective ratings as a measure of idea quality, Experiment 2 used a more objective measure based in originality of responses. To assess the originality of ideas, first the frequency of each solution in the sample was computed (e.g., Friedman et al., 2003; Kohn & Smith, 2010; Taylor et al., 1958). Ideas suggested by a smaller percentage of the sample are considered more original. From this data, the total number of highly original, or unique, ideas was computed (the number of ideas suggested by only one person in the sample) for each group. Four groups were dropped from all analyses due to inconsistencies in data.

Results

Self-Report of Enjoyment
As shown in Table 2, members of the interacting groups reported higher task satisfaction ($M = 3.65, SD = .96$) than individuals in nominal groups ($M = 3.36, SD = 1.00$), $F(1, 249) = 5.75, p < .05, \eta^2 = .02$.

**Idea Quantity**

The average number of non-redundant ideas generated by the interacting and nominal groups in each prompt condition are shown in *Figure 1*. A 2 (prompt: alternate uses, improvements) $\times$ 2 (setting: interacting, nominal) between-subjects ANOVA with the total number of non-redundant ideas as the dependent variable revealed a significant main effect of setting. Nominal groups generated more ideas ($M = 80.47, SD = 29.68$) than interacting ones ($M = 64.67, SD = 27.79$), $F(1, 82) = 6.32, p < .05, \eta^2 = .07$. However, this main effect was qualified by a marginally significant interaction between prompt and setting, $F(1, 82) = 3.91, p < .06, \eta^2 = .05$. As can be seen in *Figure 1*, post-hoc tests using Tukey’s HSD showed that on the improvements prompt, nominal groups outperformed interacting ones, $p < .05$. In contrast, there was no difference in the number of generated ideas between the two group types on the alternate uses prompt, $ns$.

**Idea Quality**

**Number of Highly Original Ideas.** The average numbers of highly original ideas generated by each group are shown in Table 2. A 2 (prompt: alternate uses, improvements) $\times$ 2 (setting: interacting, nominal) between-subjects ANOVA revealed a marginally significant interaction between prompt and setting, $F(1, 82) = 3.97, p < .06, \eta^2 = .05$. Tukey’s HSD post-hoc tests showed that given the improvements prompt, nominal groups came up with a larger number of unique ideas than interacting groups, $p < .05$. However, this gap was eliminated in the alternate uses prompt condition, $ns$. 
Number of Semantic Categories. A 2 (prompt: alternate uses, improvements) x 2 (setting: interacting, nominal) between-subjects ANOVA revealed a significant main effect of setting, with nominal groups sampling from more categories ($M = 20.63, SD = 2.90$) than the interacting groups ($M = 17.42, SD = 4.80$), $F(1, 82) = 14.34, p < .05, \eta^2 = .15$. However, there was also a significant interaction between prompt and setting, $F(1, 82) = 6.35, p < .05, \eta^2 = .07$. Post-hoc tests using Tukey’s HSD indicated that given the improvements prompt, nominal groups sampled more categories than the interacting ones, $p < .05$. However, given the alternate uses prompt, interacting and nominal groups performed equally well, $ns$.

Discussion

In sum, the results of this experiment support Hypothesis 3, which predicted that groups would benefit more from cognitive stimulation (idea sharing) given the alternate uses rather than the improvements prompt. The results showed that the interacting groups brainstorming on improvements to vehicles were less productive in terms of both idea quantity and quality than the nominal groups, but this gap was eliminated when they brainstormed about alternate uses for vehicles. These results are consistent with the well-documented process loss that has been observed in studies using improvements prompts for brainstorming (Larson, 2010; Mullen et al., 1991). In contrast, this study found that interacting and nominal groups performed equally well in terms of both idea quantity and quality on the alternate uses prompt. Although no group “synergy” (Larson, 2010) or “process gain” (Steiner, 1972) was observed, the closing of the performance gap between interacting and nominal groups with the alternate uses questions is a valuable result and still provides an exception to the more typical findings.
General Discussion

This research investigated whether the kind of question that is posed during a brainstorming task affects individual and group productivity, with a more specific goal to pinpoint how exposure to other people’s ideas influences creativity and to identify the conditions that are optimal for reducing process loss and potentially observing benefits of cognitive stimulation in brainstorming groups. Evidence in support of the prediction that the alternate uses and improvements brainstorming questions are not equivalent and differentially affect ideational performance was found in both experiments. Therefore, the two prompts should not be treated interchangeably in the literature. Further, this result suggests a closer examination of the third type of prompt used commonly in brainstorming studies, consequences of hypothetical scenarios, also deserves attention in future research.

The finding that interacting groups showed a detriment in both idea quantity and quality when given the improvements prompt, but that this “process loss” was eliminated when given the alternate uses prompts suggests that one possible reason for so consistently observing process loss in the group brainstorming literature is over-reliance on improvements prompts (e.g., Baruah & Paulus, 2008; Diehl & Stroebe, 1987; Kohn & Smith, 2010; Nijstad et al., 2002). The findings from the present research imply that benefits of idea sharing are more likely to be found on the alternate uses prompts. The results also support the notion that perhaps one of the reasons contributing to the finding of group synergy in the study by Paulus and Yang (2000) could be because they used an alternate uses prompt (other uses for a paper clip) unlike most other research on the topic. The use of an electronic communication technology (as opposed to face-to-face idea sharing) may also have been critical for avoiding process loss from collaboration in the present study. As organizations move increasingly to using virtual teams, more research is
needed to understand how innovation in non-face-to-face settings may allow collaborative teams to avoid costs and harness benefits from their asynchrony and geographic diversity (Nemeth & Goncalo, 2005; Nemiro, 2002).

Another interesting opportunity for future investigation is to better understand and provide a more robust empirical test for cognitive and social mechanisms that might drive these performance differences between the prompts. For instance, one future direction would be to manipulate fixation by having participants begin the group brainstorming session after they have reached an impasse individually. This setup would provide a more effective, personalized assessment of overcoming fixation in interactive brainstorming. If overcoming fixation on the alternate uses prompt is a significant factor in reaping the benefits of cognitive stimulation in groups, more benefits of group interaction should be observed on the alternate uses prompt compared to the improvements prompt.

Although no advantage was observed due to engaging in collaborative brainstorming and sharing ideas with others in the present research, the closing of the interacting-nominal group performance gap due to the manipulation of the brainstorming prompt provides a substantial insight. The differences observed in performance between the two prompts sets the stage for additional research that further explores the cognitive and social mechanisms that may be involved in the relationship between brainstorming prompt and ideational performance.

References


Psychological Review, 82, 407-428.


Table 1

*Means, Standard Deviations, *t*, *p*-values, and effect sizes for *t*-tests Comparing Alternate Use and Improvements Prompts in Experiment 1*

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Alternate Uses</th>
<th>Improvements</th>
<th><em>t</em></th>
<th><em>p</em>-value</th>
<th><em>Ƞ</em>²</th>
</tr>
</thead>
<tbody>
<tr>
<td>How often felt “stuck”&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.00</td>
<td>.98</td>
<td>3.30</td>
<td>1.29</td>
<td>2.73</td>
</tr>
<tr>
<td>Interference from early ideas&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.39</td>
<td>1.06</td>
<td>2.67</td>
<td>1.16</td>
<td>2.84</td>
</tr>
<tr>
<td>Thinking about question prior to study&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.92</td>
<td>1.04</td>
<td>2.47</td>
<td>1.41</td>
<td>1.99</td>
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<tr>
<td>Difficulty in generating ideas</td>
<td>3.63</td>
<td>1.04</td>
<td>3.35</td>
<td>1.25</td>
<td>1.08</td>
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<td>Idea quantity</td>
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<td>13.89</td>
<td>17.61</td>
<td>13.23</td>
<td>.99</td>
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<td>Number of highly rated ideas&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.90</td>
<td>2.59</td>
<td>5.47</td>
<td>4.41</td>
<td>3.40</td>
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<tr>
<td>Number of semantic categories</td>
<td>9.29</td>
<td>3.37</td>
<td>9.53</td>
<td>5.20</td>
<td>.26</td>
</tr>
</tbody>
</table>

<sup>a</sup> These self-report measures were assessed using a 5-point scale with 1 = strongly disagree, 5 = strongly agree.

<sup>b</sup> Ideas that received an average rating of 3 or higher on a 5-point creativity scale.
Table 2

*Means and Standard Deviations (in Parentheses) for Dependent Variables in Experiment 2*

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Alternate Uses</th>
<th>Improvements</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Interacting groups</td>
<td>Nominal groups</td>
</tr>
<tr>
<td>Self-report of Enjoyment</td>
<td>3.81 (0.95)</td>
<td>3.40 (0.96)</td>
</tr>
<tr>
<td>Idea Quantity</td>
<td>73.76 (28.01)</td>
<td>77.05 (31.85)</td>
</tr>
<tr>
<td>Number of highly original ideas</td>
<td>17.57 (10.36)</td>
<td>17.25 (10.71)</td>
</tr>
<tr>
<td>Number of semantic categories</td>
<td>19.00 (4.07)</td>
<td>20.05 (3.14)</td>
</tr>
</tbody>
</table>
Figure 1. Idea quantity as a function of prompt and setting in Experiment 2 (Error bars represent standard error of the mean.)
Appendix A

Semantic Categories for Idea Variety Coding

Alternate Uses Prompt

A. Weapon/tool (shovel, knife, axe, window as poking device)
B. Use parts for other obvious purposes (honk for sound, seats as furniture, lights to see, windows in the house, carpet as blanket, clock for time, wiper fluid to clean, mirror to look, GPS to navigate, CD player to listen, as beds, for furniture)
C. Children-related (kid’s playground, kid’s area, rock a baby to sleep)
D. Animals/pets related (dog house, for animals to live, fishtank)
E. Shelter/protection/housing (to sleep, to rest, to live, to protect yourself from weather/animals, to be alone, treehouse, to warm up, hospital, bathroom, eat/drink, brush teeth)
F. Social place/other people (to hang out, to spend time with family, to have sex in, to propose, to have a date)
G. Alone space (escape others, as a punishment, to pray, to meditate, to be naked in, to talk on the phone, changing room)
H. Working space (to devise a plan, to study, as an office)
I. Art (make jewelry, decorate, as a float, parade, self-expression)
J. Music-related (musical instruments, honk as instrument)
K. Commercial/promotion/financial purposes (to sell things, ice cream truck, store, to showcase things, to promote things, to sell parts, to make money)
L. Building material for/making other things (build robot, built other cars, build a house, transformers, build an airplane, a boat, recycle)
M. Prop (prop in movies and commercials, photo shoot, stunts, car shows)
N. Keepsake/hobby (as a trophy, to admire, to collect, to keep in garage)
O. Using its weight/size for things (paper press, to block things off, to pull heavy things, ladder)
P. Teaching/training/testing purposes (experiments, teach in, learn about parts, practice to drive, crash and safety tests, testing new fuel sources)
Q. Showing status (to show off, to show class, social status, to pick up girls)
R. Racing/sports/exercise (skate, ski, swim, to exercise, as a gym)
S. Frustration release/revenge (smash it to release anger, annoy neighbors, damage car itself)
T. Cooking/food related (for grilling, to cook food on top of car, as a stove, to cook an egg, as a fridge)
U. Clothing (make t-shirts, seatbelt as belt, use fabric to make outfits)
V. Destruction (explosives, knocking things down, running over a fence/animals, damage things)
W. Criminal/illegal (robbing a bank, chasing criminals, kidnapping, stalking, selling drugs, smoke pot)
X. Electricity/power (to generate energy, jump start other cars)
Y. Personify/Animate cars (to be your friend, superhero, talk to your car, marry it)
Z. Storage (store items, wastebasket, garbage, container of sorts, mailbox, plant holder, greenhouse)
AA. Entertainment/fun (hold parties, stargaze, to watch movies, outdoor theater, take it apart for fun, dance floor, tire as a swing, runway, sunbathe)
BB. Gift/bribe/donation (reward stuff)
CC. Other

Improvements Prompt

A. Special needs (pregnancy, disability, pets, elderly)
B. Seating (seats, seatbelts, cupholders, seating fabric/material, food tray)
C. Windows (all windows, windshield, windshield wipers, sunroof, convertible, tint)
D. Wheels/tires (anything about wheels, winter driving, flipping over)
E. Floors (carpet, mats)
F. Doors (how they open, how many, auto locks)
G. Lights (headlights, visibility, interior lights)
H. Steering wheel
I. Brakes (sensitive brakes)
J. Exterior (metal, material, scratchfree, bumper, shock absorbance)
K. Battery/engine (speed, horsepower, battery life, backup power)
L. Driving quality (smooth drive, potholes, mechanical noise)
M. Parking (self-park, assistance, shrink to fit size)
N. Aesthetics (design, colors, bulk, design, sleeker)
O. Navigation (GPS, auto navigation, windshield GPS)
P. Space, storage/organization (trunk space, storage, compartments, luggage, space, size, legroom)
Q. Heating/cooling (temperature, ventilation, auto adjustment)
R. Gas/fuel (fuel economy, gas tank, alternative fuel sources)
S. Environment friendly (electric, exhaust)
T. Affordability (price, standard cars)
U. Other modes of transport (float, fly, teleport, convert from van to sedan, transformers, robots)
V. Entertainment (music, radio, games, TV, headphones)
W. Security (anti-theft, fingerprinting, tracking, passcodes, cameras, access to car, camera to observe accidents)
X. Safety (airbags, emergency calls/buttons, safety kits, bluetooth, mirrors, cameras, blindspot, safety rules and regulations, Breathalyzer, accident related)
Y. Technology (wifi, internet, phone, computers, tablets, outlets, chargers, smart car, touch screen, voice activation, police radar, self-drive, cruise control)
Z. Maintenance (self-clean, parts change, durability of parts, AAA, OnStar, roadside assistance)
AA. Other comfort/convenience (bathroom, vacuum, fridge, microwave, water dispenser, snack bar, air fresheners, luxury features)
BB. Drivers (driving age, more practice)
CC. Other