

**Individual and Group Brainstorming:**

**Does the Question Matter?**

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THESIS

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## **DEDICATION**

This thesis is dedicated to my loving family, whose support, encouragement, and unconditional positive regard made this long journey possible.

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## TABLE OF CONTENTS

<b><u>CHAPTER</u></b>	<b><u>PAGE</u></b>
1. INTRODUCTION .....	1
1.1.    Alternate Uses and Improvements Prompts.....	1
1.1.1    Alternate Uses Prompts .....	1
1.1.2    Improvements Prompts .....	3
1.2    Process Loss in Group Brainstorming.....	3
1.3    The Argument for Cognitive Stimulation.....	4
1.4    Does Cognitive Stimulation Depend on the Prompt? .....	5
1.5    Overview of Experiments .....	8
2. EXPERIMENT 1 .....	10
2.1    Method .....	12
2.1.1    Design and Participants .....	12
2.1.2    Procedure .....	12
2.2    Results and Discussion .....	13
3. EXPERIMENT 2 .....	16
3.1    Method .....	18
3.1.1    Design and Participants .....	18
3.1.2    Cognitive Stimulation Manipulation .....	18
3.1.3    Procedure .....	20
3.1.4    Scale Reliability .....	21
3.1.5    Coding .....	22
3.1.6    Cases Dropped from Analyses .....	23
3.2    Results .....	24
3.2.1    Effects of Cognitive Stimulation and Brainstorming Prompts on Performance .....	24
3.2.1.1    Idea Quantity .....	24
3.2.1.2    Average Idea Quality & Number of Highly Creative Responses ...	25
3.2.1.3    Average Originality .....	26
3.2.1.4    Number of Highly Original Responses .....	26
3.2.1.5    Number of Semantic Categories .....	26
3.2.2    Self-report Measures.....	27
3.2.3    Mediating Role of Fixation and Idea Pre-formation .....	29
3.3    Discussion .....	31
4. EXPERIMENT 3.....	32
4.1    Method.....	32
4.1.1    Design and Participants .....	32
4.1.2    Procedure .....	33
4.1.3    Coding .....	34
4.1.4    Cases Dropped from Analyses .....	35
4.2    Results .....	35
4.2.1    Effects of Brainstorming Prompt and Group Setting on Performance..	35

## TABLE OF CONTENTS (continued)

<b><u>CHAPTER</u></b>	<b><u>PAGE</u></b>
4.2.1.1 Idea Quantity.....	37
4.2.1.2 Average Idea Originality.....	38
4.2.1.3 Average Idea Quality & Number of Highly Creative Responses	39
4.2.1.4 Number of Highly Original Ideas .....	39
4.2.1.5 Number of Semantic Categories .....	39
4.2.2 Self-report Measures .....	41
4.2.3 Mediating Role of Fixation and Idea Pre-formation .....	41
4.3 Discussion .....	43
5. GENERAL DISCUSSION .....	45
5.1 Conclusion .....	50
6. CITED LITERATURE .....	51
7. APPENDICES .....	56
7.1 Appendix A .....	56
7.2 Appendix B .....	58
7.3 Appendix C .....	59
7.4 Appendix D .....	61
7.5 Appendix E .....	62
7.6 Appendix F .....	67
7.7 Appendix G .....	70
8. HUMAN SUBJECTS COMMITTEE PROTOCOL APPROVAL .....	71
9. CURRICULUM VITAE.....	72

## LIST OF TABLES

<b><u>TABLE</u></b>	<b><u>PAGE</u></b>
I. MEANS, STANDARD DEVIATIONS, $t$ , AND $p$ -VALUES FOR $t$ -TESTS COMPARING ALTERNATE USES AND IMPROVEMENTS PROMPTS IN EXPERIMENT 1	14
II. MEANS AND STANDARD DEVIATIONS (IN PARENTHESES) FOR EACH CONDITION IN EXPERIMENT 2	28
III. BOOTSTRAP COEFFICIENTS AND BIAS CORRECTED 95% CONFIDENCE INTERVALS (IN BRACKETS) FOR INDIRECT EFFECTS OF PROMPT ON PERFORMANCE THROUGH FIXATION AND IDEA PRE-FORMATIONB IN EXPERIMENT 2	30
IV. MEANS AND STANDARD DEVIATIONS (IN PARENTHESES) FOR EACH CONDITION IN EXPERIMENT 3	36
V. BOOTSTRAP COEFFICIENTS AND BIAS CORRECTED 95% CONFIDENCE INTERVALS (IN BRACKETS) FOR INDIRECT EFFECTS OF PROMPT ON PERFORMANCE THROUGH FIXATION AND IDEA PRE-FORMATIONB IN EXPERIMENT 3	43

## LIST OF FIGURES

<b><u>FIGURE</u></b>	<b><u>PAGE</u></b>
1. Moderated mediation model tested in Experiments 2 and 3	9
2. Total number of non-redundant ideas as a function of idea generation prompt and group type in Experiment 3.	38

## **LIST OF ABBREVIATIONS**

ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
CI	Confidence Interval
EBS	Electronic Brainstorming
LSA	Latent Semantic Analysis
M	Mean
n	Number in subgroup
ns	Non-significant
r	Pearson Correlation Coefficient
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
t	Test Statistic Based on Gasser's Student Distribution



## SUMMARY

One goal of this research is to test whether the kind of question that is used to prompt brainstorming differentially affects individual and group idea generation performance. More specifically, I examined if questions (prompts) that require groups to generate alternate uses for common objects (e.g., other uses for cars) foster more benefits from collaborative ideation than questions to improve an object, place, or process (e.g., ways to improve cars). It was also predicted that the amount of fixation and prior thought on the topic (idea pre-formation) would mediate the relationship between prompt and performance. These hypotheses were tested in a series of three experiments using electronic idea exchanges to minimize other obstacles to group productivity. Participants generated ideas using alternate uses or improvements prompts for the same topic (cars) (Experiment 1). In Experiment 2, timing of exposure to others' ideas (early, late, or none) was varied. In Experiment 3, participants brainstormed in response to one of the two prompts in either an interactive group setting (exchanging ideas with others) or individually (no idea sharing). The results of all three experiments showed that alternate uses and improvements prompts indeed differentially affect ideational performance in terms of both idea quantity and quality. The results were also consistent with the well documented "process loss" (Larson, 2010; Mullen, Johnson, & Salas, 1995) on the improvements prompt, but the gap between interacting and nominal groups was closed on the alternate uses prompt. However, the mediating roles of fixation and idea pre-formation were not supported.

## **1. INTRODUCTION**

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 as the generation of novel and useful ideas (e.g., Amabile, 1996; Diehl & Stroebe, 1987; Mayer, 1999). A popular technique to generate creative ideas is brainstorming, and it has received a lot of attention in creativity research.

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; DeDreu, 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, however, they also differ in several characteristics that may differentially affect individual brainstorming performance. Moreover, these differences may impact the opportunity for reaping the benefits of cognitive stimulation that can result from idea sharing. This dissertation focuses on the differences between alternate uses and improvements prompts.

### **1.1 Alternate Uses and Improvements Prompts**

#### **1.1.1 Alternate Uses Prompts**

Two characteristics of questions that prompt brainstormers to consider different uses for common objects or tools (alternate uses prompts) are relevant for considering how they may

impact individual performance, as well as their subsequent effects on group ideation. 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 pre- or fully formed in an individual's long-term memory prior to the brainstorming session (low idea pre-formation). A related characteristic of alternate uses brainstorming prompts is that the generation of ideas involves overcoming functional fixedness. Functional fixedness 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 (Duncker, 1945; Glucksberg & Weisberg, 1966). 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 have consequences for individual brainstorming performance. Ideas may be generated at a relatively slow rate for two reasons. First, according to spreading activation theories (Collins & Loftus, 1975), more closely and typically co-occurring concepts will receive the most activation and will have a greater probability of being retrieved from long-term memory than closely related concepts. Creating new combinations of seemingly unrelated concepts, the defining characteristic of alternate uses prompts in my view, will 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 will experience difficulty coming up with remote combinations of ideas and escaping their own fixation.

### **1.1.2 Improvements Prompts**

In contrast to the 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 difficulties resulting from functional fixedness. Undergraduate students, who are the typical participants in brainstorming research studies, may have spent time already thinking about potential improvements to their university or to common objects. As a result, during a brainstorming session, for improvements questions, idea pre-formation may be relatively high. Many candidate solutions may be available in long-term memory and can simply be accessed and retrieved rather than generated. 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. Therefore, the prediction is that the two brainstorming questions are not equivalent and will differentially impact idea generation performance.

### **1.2 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 (Paulus & Brown, 2003). However, decades of empirical research on brainstorming 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, 1995). 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 allow the creative potential of groups to be realized.

### **1.3 The Argument for Cognitive Stimulation**

According to socio-cognitive models of group brainstorming, cognitive stimulation resulting from idea sharing in group settings is possible. For example, the Associative Memory Matrix (AMM) model (Brown, Tumeo, Larey, & Paulus, 1998; Paulus & Brown, 2003) posits that a two-dimensional associative memory matrix can be constructed for each individual in a group, with varying probabilities representing the fluency and accessibility of different semantic categories associated with the brainstorming topic. Category fluency refers to the probability that a new idea will be generated while a brainstormer considers a given category, and accessibility is the probability of switching to a particular new category. According to the AMM model, the semantic category of the next idea a brainstormer will generate depends on the semantic category of the previous idea and the associated transition (switching) probability of the semantic category in question (Brown et al., 1998). In the group context, the previous idea that determines where in the semantic network the next idea will come from, can be either an

individual's own or another group member's idea. In this way, the model accounts for cognitive stimulation in group brainstorming: if attention is paid to others' ideas, it can allow team members to switch to a semantic category that they would not consider individually (Paulus & Brown, 2003).

Nijstad and Stroebe (2006; Nijstad, Diehl, & Stroebe, 2003) proposed an alternative model called Search of Ideas in Associative Memory (SIAM) to explain how synergy happens in group brainstorming. Whereas AMM explains the structure and content of brainstormers' semantic networks and retrieval of ideas from long-term memory, the focus of SIAM is to account for the search processes and formation of novel ideas in that semantic space (Paulus & Brown, 2003). In other words, SIAM does not assume that creative ideas are always fully formed in an individual's mind. According to this model, idea generation happens in two stages. The first stage is a controlled process that involves using a search cue to probe the activation of task-relevant concepts in long-term memory. The second step is automatic, and ideas are generated by forming new associations between the features of activated knowledge ("images") and domains of the problem at hand. The SIAM model assumes that category switches require a new search cue and an activation of a new image – an effortful, time-consuming process. In group settings, however, features of stimulus ideas that come from other people can be incorporated into the search cues and help reduce response latencies associated with category switches. In sum, both models predict positive effects from group brainstorming, and the consideration of a broader array of solutions than would be expected in individual contexts.

#### **1.4 Does Cognitive Stimulation Depend on the Prompt?**

Despite these theoretical accounts that suggest that group brainstorming should lead to cognitive stimulation, as noted above few empirical studies have been able to demonstrate group

advantages, and most studies find evidence for process loss. One unexplored factor that could potentially explain the discouraging results in the search for cognitive stimulation in group settings is the role of the question that is asked to prompt brainstorming. A close examination of the brainstorming literature reveals a potentially critical difference between the question prompts used in research studies on individual creativity and studies exploring the benefits of group brainstorming. Individual brainstorming studies, including those that assess creativity using the Torrance Tests of Creative Thinking (TTCT; Torrance, 1962, 1972, 2008), tend to employ a variety or a combination of the three question types. In contrast, group brainstorming researchers almost always rely either on improvements or consequences of hypothetical scenarios questions. One exception is a 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 percent more ideas than their nominal groups, a truly atypical result. Therefore, it is possible that one reason why interacting groups were found to be more productive than nominal groups in this study is because it used an alternate uses question.

Alternate uses questions may be particularly conducive for allowing groups to capitalize on the creative potential of different cognitive architectures, mindsets, and perspectives that a group brings, to a greater extent than other question types. To test this possibility, one goal of the proposed research is to test whether the kind of question that is used to prompt brainstorming leads to differences in the opportunity for cognitive stimulation to occur in idea-sharing groups. Specifically, this research tested whether or not prompts that require groups to generate alternate uses for common objects (e.g., other uses for cars) foster more benefits from collaborative ideation than prompts to improve an object, place, or process (e.g., ways to improve cars).

Idea generation difficulties due to low idea pre-formation and high fixation experienced on the alternate uses prompts by individual brainstormers is precisely the reason why group interaction may lead to facilitated problem solving with these prompts. Idea generation rate and creativity of solutions on the alternate uses prompt might actually be boosted in a group setting because exposure to others' ideas can help group members overcome fixation. Hearing or reading others' input can provide the much-needed external stimulation when individuals experience mental blocks and are unable to either switch to a new category of ideas or generate *any* new ideas. In such instances, individuals will benefit from group interactions by coming up with more numerous and diverse solutions. Thus, exposure to others' ideas will have stimulating effects on solutions to alternate uses questions.

This prediction is also consistent with suggestions made by others that group stimulation 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 are individuals in need of external stimulation from others' ideas.

In contrast to the alternate uses prompts, higher idea pre-formation and lower likelihood of fixation on the improvements brainstorming prompts should lead to relatively less difficulty for the individuals in generating solutions. Lower difficulty may leave less opportunity for cognitive stimulation in a group setting. Further, it is even possible that exposure to others' ideas will be distracting because it can disrupt the natural flow of a group member's ideas (Nijstad, Stroebe, & Lodewijkx, 2002) and can result in fixation on the ideas of others (Smith, 2003).



Fixation will decrease the number of ideas that groups generate. Moreover, fixating on others' ideas may also result in lower idea variety (Kohn & Smith, 2010). Thus, there are several possible reasons to predict that improvements prompts may results in less cognitive stimulation than the alternate uses prompts.

### **1.5 Overview of Experiments**

One goal of this research is to test the general prediction that the alternate uses and improvements brainstorming questions are not equivalent and differentially impact ideational performance. Another goal is to test whether the two prompts afford the same opportunity for cognitive stimulation to occur in idea-sharing groups. These research questions are explored in a series of three experiments. In Experiment 1, individuals generated ideas using alternate uses or improvements prompts for the same topic (cars). Experiment 2 addressed whether exposure to other people's ideas differentially influenced performance in response to these prompts. The timing of exposure to others' ideas (early, late, or none) was varied. In Experiment 3, participants brainstormed in response to one of the two prompts in either an interactive group setting (exchanging ideas with others) or individually (no idea sharing). In addition to the general research question about performance differences between the two prompt types, three specific hypotheses were tested:

*Hypothesis 1:* Individuals will experience more fixation when given alternate uses prompts than improvements prompts.

*Hypothesis 2:* More benefits of cognitive stimulation (i.e. being exposed to the ideas of others) will be seen with alternate uses prompts than improvements prompts. Individuals will gain more from exposure to others' ideas when given alternate uses prompts than improvements

prompts. Interacting groups will benefit more when given alternate uses prompt compared to the improvements prompt.

*Hypothesis 3:* Idea pre-formation and the amount of fixation will mediate the relationship between prompt type and ideational performance, but this pathway will be moderated by group type/cognitive stimulation condition. For the nominal group/no-stimulation conditions, alternate uses prompts will be associated with lower idea pre-formation and greater amount of fixation than improvements prompts, which will subsequently relate to decreased performance. However, for the interacting group/cognitive stimulation conditions, idea pre-formation and the amount of fixation will not mediate performance (see Figure 1).

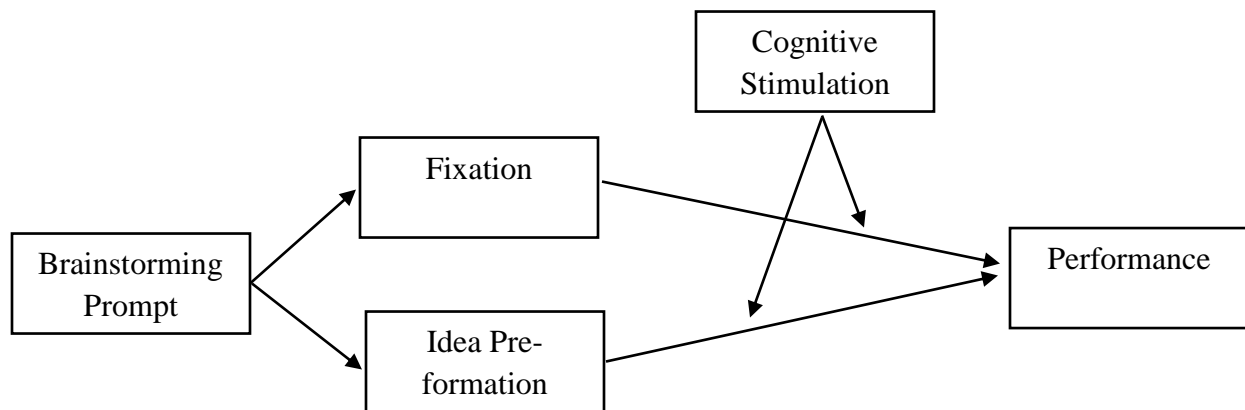


Figure 1. Moderated mediation model tested in Experiments 2 and 3.

## 2. EXPERIMENT 1

To provide initial empirical evidence of the differences between the alternate uses and improvements prompts, a study of individual brainstorming was conducted. The goal of this first experiment was to test if individual performance in terms of the number and quality of ideas, as well as scores on the proposed mediating variables, change as a function of the question used to prime brainstorming. If differences in performance, the amount of fixation, and the extent of idea pre-formation, are found in solitary brainstorming contexts, then it suggests that the two prompts may differ in the opportunities they provide for cognitive stimulation (group interaction and exposure to others' responses) to facilitate performance. Based on the rationale that individuals are more likely to have thought about improvements to cars than alternate uses of cars, it was predicted that the alternate uses prompt might be more difficult and more likely to lead to impasses than the improvements prompt. Conversely, it was predicted that individuals would report more idea pre-formation in relation to the improvements prompt. Specifically, the experiment was designed to test *Hypothesis 1*, that the alternate uses prompt would lead to more fixation than the improvements prompt for individuals.

The present studies all used an electronic brainstorming format instead of face-to-face brainstorming to minimize production blocking, and to create conditions similar to those that have been found to produce the best group results in the literature. Paulus and Yang (2000) attributed their rare finding of an interacting group advantage over their nominal group counterparts to the idea generation procedure they used called "brainwriting". In their study, instead of contributing ideas to the group orally, as it is traditionally done in brainstorming research, participants wrote their ideas on cards that were rotated among group members. Participants were asked to read and pay attention to the ideas on the cards they received from

their neighbors before adding their own ideas. There were several cards in circulation simultaneously, allowing group members to generate ideas continuously without waiting for their turn. Thus, this “brainwriting” procedure (VanGundy, 1981) was presumed to reduce production blocking. It was also presumed to decrease social loafing because participants used different colored pens, which increased the identifiability of individual responses. In sum, there were multiple features of the brainwriting procedure that might have contributed to the superior performance by interacting groups in Paulus and Yang (2000).

An alternative to the brainwriting procedure is electronic brainstorming (EBS). EBS is a way to 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). It is proposed that just like brainwriting, 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. In addition, when individual contributions are made anonymously, EBS can also mitigate evaluation apprehension concerns, or withholding certain ideas from the group because of the fear to be judged negatively (Dennis & Valacich, 1993, 1994) although it should also be noted that anonymity might contribute to social loafing. 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. Thus, empirical evidence suggests that EBS can also be effective in minimizing some of the process loss factors associated with group idea sharing. EBS was chosen as a format for the present studies to optimize the likelihood of

cognitive stimulation in groups. To be consistent across studies, the individuals in this first study also used an EBS interface to collect responses.

## **2.1 Method**

### **2.1.1 Design and Participants**

Seventy-nine undergraduate students from the UIC Psychology Subject Pool participated for course credit to be applied toward their undergraduate research experience component of the grade for Introductory Psychology. They were randomly assigned to brainstorm individually in response to either the alternate uses ( $n = 48$ ) or improvements prompt ( $n = 32$ ).

### **2.1.2 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: 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. 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, and/or vans other than for transportation or about potential improvements to these vehicles.

Immediately following the individual brainstorming session, participants filled out a questionnaire that assessed their perceptions of the brainstorming session, as well some general demographic information (see Appendix A). Importantly, the questionnaire assessed the variables presumed to mediate the relationship between prompt type and ideational performance. Two items served as an 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.” The extent of idea pre-formation was gauged with responses to the following statement: “I have thought about/considered improvements/other uses for cars, SUVs, and/or vans before this experiment.” A five-point Strongly Disagree to Strongly Agree response scale was used for all items.

## **2.2 Results and Discussion**

As shown in Table I, 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 on 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 (i.e., “It was difficult for me to keep generating new, additional ideas”), ruling out the alternative explanation of the improvements questions simply being easier for brainstormers.

**TABLE I**

MEANS, STANDARD DEVIATIONS, *t* AND *p*-VALUES FOR *t*-TESTS COMPARING ALTERNATE USES AND IMPROVEMENTS PROMPTS IN EXPERIMENT 1

Dependent Variable	<u>Alternate Uses</u>		<u>Improvements</u>		<i>t</i>	<i>p</i> -value
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
How often felt “stuck” <sup>a</sup>	4.00	.98	3.30	1.29	2.73	.01
Interference from early ideas <sup>a</sup>	3.39	1.06	2.67	1.16	2.84	.00
Thinking about question prior to study <sup>a</sup>	1.92	1.04	2.47	1.41	1.99	.07
Number of ideas	21.69	14.03	19.93	14.03	.53	.60
Number of high quality ideas <sup>b</sup>	2.83	3.07	5.24	4.98	1.48	.15
Proportion of high quality ideas <sup>b</sup>	.15	.17	.35	.22	5.31	.00
Difficulty in generating ideas	3.63	1.04	3.35	1.25	1.08	.28

<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 a rating of 3 or higher on a 5-point creativity scale.

Idea transcripts generated for each participant were scored for the total number of non-redundant responses. The results revealed no overall differences in idea quantity between the alternate uses and improvements prompts. The ideas were also analyzed for quality using a subjective assessment technique recommended by Silvia and colleagues (2008). According to this holistic approach to creativity ratings, a 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 (see Appendix B for detail). 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 rating above the midpoint of the scale (higher than 3.00) were considered high quality. The proportion of high quality responses was computed for each participant. The results showed that the alternate uses prompt led to a lower proportion of high quality ideas compared to the improvements prompt.

The results of the first experiment provide empirical support for the idea that alternate uses and improvements prompts differentially affect performance. The results from idea quality coding showed that alternate uses prompts resulted in a lower proportion of high quality ideas in individual brainstorming, suggesting that the two prompts are not equivalent. The results also support *Hypothesis 1* predicting that alternate uses prompts may be more fixating for individuals than improvements prompt, and are consistent with the suggestion that alternate uses prompts will provide more of an opportunity for improvement in group settings than will improvements prompts.



### 3. EXPERIMENT 2

The results of Experiment 1 provide initial empirical support for the idea that alternate uses prompts lead to lower idea quality and may be more fixating for individuals than improvements prompts. Experiment 2 provides another test of this hypothesis. In addition, the next question to be addressed is whether exposure to other people's ideas differentially influences performance in response to these prompts. Experiment 2 manipulated exposure to stimulus ideas in a controlled environment to examine how such exposure may affect the number, range, and creativity of solutions on the alternate uses versus improvements prompts. Varying the presentation time of others' ideas provides a test of the proposed stimulation effects as well as clarify the role of fixation as an explanation of performance differences between the two prompts found in Experiment 1.

I manipulated exposure to others' ideas by presenting them to individuals either at the beginning or later in the brainstorming session, or not at all. When provided at the beginning, exposure to others' ideas may lead to fixation in the form of conformity to the provided exemplars, and thus restrict the range of generated solutions (e.g., Jansson & Smith, 1991; Smith, Ward, & Schumacher, 1993). When provided later in the session, particularly at the time when individuals' natural idea generation rates tend to slow and they may reach an impasse, exposure to others' ideas may be beneficial and stimulate a new train of thought and set of ideas. For example, evidence suggests that alternating individual and group brainstorming may be a promising technique because it minimizes the potential for blocking and allows the opportunity for stimulation (Baruah & Paulus, 2008). Because of the proposed differences between alternate uses and improvements prompts in the amount of fixation and the extent of idea pre-formation, I predict that the effects of early versus late exposure to others' ideas will vary as a function of the

brainstorming prompt. On the one hand, since alternate uses questions are already characterized by fixation, early exposure to stimulus ideas should not impact individuals' performance. On the other hand, it is also possible that providing other people's ideas at the beginning of the brainstorming session can exacerbate fixation and make individuals prone to even more impasses compared to no exposure. In contrast to the alternate uses prompts, early exposure to others' ideas should hurt individual performance on the improvements questions by inducing fixation in the form of conformity to the provided examples and limiting the range of explored ideas. However, when provided later in the brainstorming session, when idea generation rates tend to naturally decline, hearing or reading others' ideas can provide external stimulation, but more so on the alternate uses than improvements prompts by providing search cues to break fixation. It is even possible that others' ideas may hurt performance on the improvements questions by interrupting an individual's train of thought (Nijstad et al., 2002).

Thus, this experiment provides a test of *Hypothesis 2*, that more benefits of cognitive stimulation (i.e. being exposed to the ideas of others) will be seen with alternate uses prompts than improvements prompts. A further prediction is that early exposure to others' ideas will hurt individuals' performance on the improvements prompt, but not on the alternate uses prompt, compared to a no exposure condition. Conversely, late exposure to others' ideas will improve the performance on the alternate uses prompt, but not on the improvements prompt, compared to a no exposure condition. Finally, analyses will be performed to test *Hypothesis 3*, that idea pre-formation and the amount of fixation will mediate the relationship between prompt type and ideational performance, but these effects should be moderated by cognitive stimulation conditions.

### **3.1 Method**

#### **3.1.1 Design and Participants**

The experiment employed a 2 prompt (alternate uses, improvements) x 3 cognitive stimulation (early exposure, late exposure, no exposure) between-subjects factorial design. Individuals were randomly assigned to conditions. In the early exposure condition, participants were presented with ideas of other people before they begin brainstorming their own ideas. In the late exposure condition, they received the same set of others' ideas halfway through the brainstorming session. Finally, there was no exposure to stimulus ideas in the control condition.

The participants in this study were 120 undergraduate students (45% female) from the UIC Psychology Subject Pool. They participated for course credit applied toward their undergraduate research experience component of the grade for Introductory Psychology. The number of participants in each of the six cells of the factorial design is reported in Table II.

#### **3.1.2 Cognitive Stimulation Manipulation**

Previous research of idea exposure effects suggests that oral and written presentation of stimulus ideas generally improves individuals' performance. For example, exposure to homogeneous stimulus ideas increased the number of ideas generated within a narrow range of semantic categories, while the heterogeneous stimulus ideas increased the range of explored categories (Nijstad et al., 2002). Because fixation is presumed to reduce mostly the breadth of explored ideas, presentation of stimulus ideas from a variety of semantic categories may help counteract this effect. Thus, in the present experiment stimulus ideas from several semantic categories were used. Moreover, Dugosh and colleagues (2000) found that exposure effects are more beneficial with a larger number of stimulus ideas (60 versus 30). However, in the present research the goal was to manipulate the timing of stimulus idea presentation (early versus late),

and thus, all stimuli were presented in a clustered form. Results from studies by Paulus and Yang (2000) and Goldenberg, Larson, & Wiley (2013) suggest that it is best to limit exposure to only a handful of these ideas at a time (i.e., four). For this reason, participants in this study were presented with four suggestions made by others.

Participants in the early and late exposure conditions were told they were receiving four ideas “generated by their peers” in response to the same prompt. The set of ideas was designed to include three frequent typical responses, and one highly creative response. The rationale for the majority of the stimulus ideas to be frequent, typical responses was to increase the likelihood of inducing fixation in the early exposure condition. However, one highly original, creative suggestion may be just enough to break fixation in the late exposure condition. All stimulus ideas were selected from data collected for Experiment 1. The typical ideas were selected based on the most frequently occurring responses in the dataset. For the improvements prompt, they were improving fuel economy, size, and safety. For the alternate uses prompt, they were suggestions to use cars for sleeping, to listen to music, and for storage. The highly creative stimulus idea for each prompt was chosen based on the creativity ratings provided by novice judges. For the improvements prompt, the solution to make cars that run on water was selected because received an average creativity rating of 4.00 on a five-point scale. For the alternate uses prompts, the solution to use parts of a car to build a robot was chosen, received a rating of 4.07 on the same scale.

The same set of four ideas was presented in both early and late exposure conditions. The only difference was the timing of presentation. In the early exposure condition, individuals heard and read solutions of their peers right before they began generating their own ideas, while in the late exposure condition, they were given these solutions after 15 minutes of solitary

brainstorming, leaving 5 additional minutes to see the influence of these stimulus ideas on brainstorming. Response latency analysis on the data collected for Experiment 1 showed that almost half (45 percent) of the sample reached an impasse after 15 minutes of brainstorming, with impasse operationalized as a response delay of at least two minutes.

No stimulus ideas were provided in the no-exposure control condition.

### **3.1.3 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 (up to four at a time) in the common area of the laboratory space. The explanation included background information on brainstorming, brainstorming rules, idea-recording procedure, and the brainstorming topic. Individuals generated ideas either about other uses for cars, SUVs, and/or vans or about improvements to these vehicles and typed them on a computer using the Google Talk instant messaging tool. In the early exposure to others' ideas condition, participants were also presented with four example ideas from previous participants in response to the same prompt. Every participant received a printed copy of these instructions and was asked to follow along as the experimenter read them out loud. Appendix C details the instructions that were given in each condition.

After answering any remaining questions, the participants moved to separate rooms and began the brainstorming activity. They brainstormed for a total of 25 minutes using the Google Talk. After five ideas, the list of generated ideas started to scroll so that only the most recent five ideas were visible. After 15 minutes, the experimenter asked all participants to fill out a brief 4-item questionnaire assessing the degree of impasse being experienced at that time. The Impasse Questionnaire can be found in Appendix D. In the late exposure condition, participants were

given four ideas from past participants (the stimulus ideas) after they completed the impasse measure. All participants resumed brainstorming for another 10 minutes. When the time was up, the experimenter opened the door, asked the participants to stop typing, and handed the final questionnaire. The Google Talk transcripts were saved automatically and included the submission time of each response to the nearest minute.

The final questionnaire included self-report measures of experienced fixation and the extent of idea pre-formation. To improve measures of these constructs over those used in Experiment 1, three items were now used to assess each (items # 7, 8, and 9 for fixation, and items # 16, 17, and 18 for idea pre-formation; see Appendix E). The questionnaire also contained 2 items designed to assess task difficulty (items # 5 and 6), as well as general questions about subjects' enjoyment of the task and perceived performance. In the exposure conditions, participants were also asked about their impressions of the effect of seeing others' ideas.

#### **3.1.4 Scale Reliability**

The four items on the Impasse Survey designed to gauge participants' progress after fifteen minutes of brainstorming was a reliable measure (Cronbach's  $\alpha = .84$ ), allowing a composite measure of impasse to be computed by averaging the items.

The three items on the final questionnaire intended to measure the extent of fixation during brainstorming showed insufficient scale reliability (Cronbach's  $\alpha = .68$ ). The item "Some of my earlier ideas got in the way of generating new, additional ideas" did not correlate with the other two items. Therefore, it was excluded, which increased Cronbach's alpha to an acceptable level of .81. The remaining two items were therefore averaged to create a composite fixation score.

The three items on the final questionnaire intended to measure the extent of idea pre-formation also showed low scale reliability (Cronbach's  $\alpha = .59$ ). Excluding any of the items did not significantly improve it. Therefore, the three items were analyzed separately. However, the results are reported for a single item, "I have thought about or considered other uses/improvements to cars, SUVs, and/or vans before this experiment," because this was the only item for which significant differences between the two prompts were found (see the Results section).

### **3.1.5 Coding**

The idea transcripts from Google Talk were coded to obtain measures of both idea quantity and quality. *Idea quantity*, the most commonly used index of brainstorming performance, was computed by counting the total number of non-redundant ideas each person generated (e.g., Baruah & Paulus, 2008; Camacho & Paulus, 1995; Dennis & Valacich, 1993; Nemeth, Brown, & Rogers, 2001).

Idea quality was measured using several established approaches. For one measure, we obtained subjective ratings of quality. In contrast to Experiment 1, rather than asking Subject Pool participants to provide ratings, we obtained creativity ratings of each unique response from three undergraduate research assistants. The raters were provided with the same definition of creativity as used in Experiment 1 and asked to rate each idea using a 5-point Likert-type scale, with 1 = not at all creative, 5 = very creative (Silvia et al., 2008). The exact rating instructions can be found in Appendix B. These ratings were meant to be used in computation of an *average idea quality* for each participant, as well as the *number of highly creative responses* (those receiving above average ratings) generated by each person.

To assess the originality of responses, 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 only a small percentage of the sample are more original. From this data, both *average originality* and the *number of highly original responses* (the number of ideas suggested by only one person in the sample) was computed.

To assess variety and flexibility of ideas, we computed the number of task-relevant semantic categories sampled by each group (e.g., De Dreu et al., 2008; Nijstad et al., 2002; Goldenberg et al., 2013). Number of categories also provided an assessment of the amount of fixation as a function of one's own previously generated responses. A narrower range of semantic categories suggests greater fixation. Appendix F lists the set of semantic categories that were used for each prompt. These categories were derived by first screening the ideas generated by participants in Experiments 2 and 3 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 *number of categories sampled* was computed for each participant.

### **3.1.6 Cases Dropped from Analyses**

A total of one hundred and twenty participants took part in the experiment. Idea transcripts from eight individuals were not saved due to computer problems, producing no codable data for these individuals. In addition, one outlier in improvements prompt, no exposure condition was dropped from analyses because of values deviating more than two standard deviations on two of the dependent variables (total number of ideas and number of highly original responses). Therefore, data for 111 participants was included in the analyses reported below.



## **3.2 Results**

### **3.2.1 Effects of Cognitive Stimulation and Brainstorming Prompts on Performance**

The first phase of analyses was performed to test the general prediction about performance differences between the two prompts, as well as *Hypothesis 2*, that more benefits of cognitive stimulation (i.e. being exposed to the ideas of others) will be seen with alternate uses prompts than improvements prompts in both the quantity and quality of ideas.

A further prediction was that early exposure to others' ideas will hurt individuals' performance in idea variety on the improvements prompt, but not on the alternate uses prompt, compared to a no exposure condition. Conversely, late exposure to others' ideas will improve the performance on the alternate uses prompt in idea variety, but not on the improvements prompt, compared to a no exposure condition. Table II includes means and standard deviations for the six cells of the 2 (prompt: alternate uses, improvements) x 3 (exposure: early, late, none) design for each of the dependent variables reported below.

#### **3.2.1.1 Idea Quantity**

Idea quantity was calculated by first counting the total number of non-redundant responses generated by each participant by two undergraduate research assistants with high inter-rater reliability (intraclass correlation coefficient (ICC) of .95 on 82 percent of data). Another coder tallied the number of ideas that were repetitions of the examples provided to participants in the early and late exposure conditions (overall  $M = 1.25$ ,  $SD = 1.12$ ). The number of non-redundant ideas was then adjusted by subtracting the number of used examples to yield an unbiased measure of idea quantity.

A 2 (prompt: alternate uses, improvements) x 3 (exposure: early, late, none) analysis of variance (ANOVA) revealed a significant main effect of prompt. Individuals generated more

ideas in response to the alternate uses ( $M = 35.62$ ,  $SD = 18.77$ ) than the improvements prompt ( $M = 27.52$ ,  $SD = 13.72$ ),  $F(1, 105) = 8.13$ ,  $p < .05$ . Participants who were exposed to the examples of others' ideas came up with more ideas ( $M = 33.62$ ,  $SD = 15.35$  and  $M = 33.55$ ,  $SD = 20.68$  for early and late exposure conditions, respectively) than participants who were not ( $M = 27.06$ ,  $SD = 14.35$ ). However, this difference failed to reach statistical significance,  $F(2, 105) = 2.18$ ,  $p = .119$ . There was no interaction between prompt type and exposure condition.

### **3.2.1.2 Average Idea Quality & Number of Highly Creative Responses**

Creativity of ideas was coded using the Subjective Assessment Technique proposed by Silvia et al. (2008). First, a master list of all unique ideas generated by participants in the combined sample for Experiments 2 and 3 was compiled for each prompt. The lists include 754 alternate uses and 661 improvements. Next, three trained undergraduate research assistants rated the creativity of each response presented in random order using a five-point scale following the definition of creativity and instructions suggested by Silvia and colleagues (see Appendix B for details). However, inter-rater reliability for this subjective assessment of idea quality was very low, with the average-measure ICC of .21 for the improvements prompt, and of .03 for the alternate uses prompt. As a result, no analyses were performed using this metric of idea quality in Experiments 2 and 3.

In Experiment 1, average ratings from twenty-nine undergraduate students blind to experimental hypotheses (novices) were used as an index of creativity of each response in the master list, but no expert ratings were collected as a preliminary measure. Although such a low agreement among raters suggests that this subjective measure of idea quality is unreliable, data coding using creativity ratings from the Subject Pool participants is in progress.

### **3.2.1.3 Average Originality**

Average originality was calculated for each participant's list of ideas based on the percentage of people in the combined sample who suggested each solution. The higher the percentage of people who mention a response, the lower the originality of that idea. These percentages were then averaged for each participant to control for the total number of generated ideas. Finally, the average percentage was subtracted from 100 to yield a measure of average idea originality.

A 2 (prompt: alternate uses, improvements) x 3 (exposure: early, late, none) ANOVA revealed only a significant main effect of prompt,  $F(1, 101) = 19.41, p < .05$ . On average, responses to the alternate uses prompt were less original ( $M = 93.40, SD = 2.45$ ) than responses to the improvements prompt ( $M = 94.89, SD = 1.41$ ).

### **3.2.1.4 Number of Highly Original Responses**

Ideas suggested by only one person in the entire sample, both Experiment 2 and 3 combined, were classified as highly original. The number of such unique responses was calculated for each participant and served as an objective measure of originality.

A 2 (prompt: alternate uses, improvements) x 3 (exposure: early, late, none) ANOVA with the number of unique responses as the dependent variable resulted in no significant effects ( $F_s < 1$  for the main effects and  $F(2, 106) = 1.21, ns.$  for the interaction). The same was true for an analysis of covariance (ANCOVA) controlling for the total number of ideas (all  $F_s < 1$ ).

### **3.2.1.5 Number of Semantic Categories Sampled**

Two undergraduate research assistants classified the responses into one of 29 mutually exclusive categories and counted the total number of categories from which each participant

sampled ideas at least once. Inter-rater reliability between the coders was high, with single-measures ICC of .92 for the improvements and .88 for the alternate uses prompt.

A 2 (prompt: alternate uses, improvements) x 3 (exposure: early, late, none) ANOVA with the number of semantic categories as the dependent variable yielded no significant effects. However, an ANCOVA with the total number of responses as a covariate resulted in a marginally significant main effect of prompt, with alternate uses ( $M = 12.78$ ,  $SD = 3.67$ ) leading to fewer semantic categories than improvements ( $M = 14.20$ ,  $SD = 3.64$ ),  $F(1, 104) = 3.90$ ,  $p = .051$ . No other effects were significant.

In sum, the results of this experiment suggest that alternate uses prompts lead to greater idea quantity, but lower quality as indexed by average originality and the number of semantic categories. However, there was no support for *Hypothesis 2*, that more benefits of cognitive stimulation (exposure to others' ideas) would be observed on the alternate uses than the improvements prompt in term of quantity or quality of ideas. Although exposure to a pre-selected list of others' ideas tended to help individuals come up with a larger number of suggestions compared to no such exposure, this effect was not more pronounced for the alternate uses prompt. Further, predictions about the influence of differential exposure to others' ideas (early versus later in the brainstorming session) on idea variety were not supported either.

### **3.2.2 Self-report Measures**

The results of analyses using self-report measures of fixation revealed no significant differences between the two prompts nor the three exposure conditions (see Table II for means and standard deviations). Specifically, no significant effects were found in the extent of impasse reached after fifteen minutes of brainstorming nor in the overall amount of experienced fixation reported in the final survey (all  $F_s < 1$ ). In contrast, participants reported having thought more

about the improvements than other uses for vehicles prior to the study,  $F(1, 108) = 24.77, p < .05$ . No significant effects were found with respect to perceived task difficulty ( $F(1, 108) = 1.30, ns$ . for the main effect of prompt,  $F_s < 1$  for the main effect of exposure and the interaction).

**TABLE II**

MEANS AND STANDARD DEVIATIONS (IN PARENTHESES) FOR EACH CONDITION IN EXPERIMENT

Dependent variable	Alternate Uses			Improvements		
	<u>Early Exposure</u> (n = 23)	<u>Late Exposure</u> (n = 14)	<u>No Exposure</u> (n = 18)	<u>Early Exposure</u> (n = 22)	<u>Late Exposure</u> (n = 17)	<u>No Exposure</u> (n = 17)
Idea Quantity	35.74 (15.63)	41.79 (25.31)	30.67 (16.01)	31.41 (15.09)	26.76 (13.13)	23.24 (11.62)
Average Originality	94.00 (1.77)	92.56 (2.77)	93.31 (2.84)	94.71 (1.19)	94.62 (1.76)	95.38 (1.10)
<sup>a</sup> Number of highly original ideas	5.45 (4.27)	6.35 (4.33)	5.98 (4.24)	5.27 (4.25)	5.19 (4.24)	6.18 (4.32)
<sup>a</sup> Number of semantic categories	13.03 (3.52)	12.86 (3.57)	12.46 (3.99)	15.01 (3.53)	14.30 (3.52)	13.28 (3.56)
Impasse	3.52 (.86)	3.64 (1.07)	3.95 (.87)	3.60 (.81)	3.49 (.96)	3.78 (.80)
Fixation	3.61 (1.07)	3.53 (1.26)	3.67 (1.19)	3.50 (1.16)	3.34 (1.19)	3.61 (.94)
Pre-formation	1.74 (1.05)	1.71 (.99)	1.71 (.78)	2.84 (1.21)	2.53 (.96)	2.74 (1.20)

Difficulty	3.26	3.14	3.50	3.11	3.00	3.16
	(.90)	(1.18)	(1.10)	(1.01)	(.91)	(.85)

<sup>a</sup>Means and standard deviations are adjusted, controlling for the total number of responses.

### **3.2.3 Mediating Role of Fixation and Idea Pre-formation**

The third phase of analyses was performed to test *Hypothesis 3*, that the extent of fixation and idea pre-formation will mediate the relationship between prompt type and ideational performance, but these indirect effects would be moderated by cognitive stimulation condition. Both mediators in this experiment were assessed with self-report measures. Two indices of fixation were obtained in this experiment. One measure was the composite score from the Impasse Survey, assessing the extent of fixation after fifteen minutes of brainstorming. However, this measure provided an index of fixation only at that specific point in time. A more useful measure came from the average of two items on the final questionnaire, asking participants about the overall amount of experienced interference resulting from their own ideas. The two measures of fixation were positively correlated ( $r(122) = .71, p < .05$ ), so only the assessment from the final questionnaire was used in analyses. A single item on the final survey, “I have thought about or considered improvements/other uses for cars, SUVs, and/or vans before this experiment,” was used in the analyses as an index of idea pre-formation, as it was the only item tapping into idea pre-formation for which significant differences between the two prompts were found (i.e., significant independent variable-mediator path).

I employed the bootstrapping strategy recommended by Hayes (2009, 2013, Model 14) to test the moderated mediation model suggested by this hypothesis. Four separate moderated mediation analyses were performed, one for each dependent variable: idea quantity, average idea

originality, number of highly original responses, and number of semantic categories. The two mediators (fixation and idea pre-formation) were entered simultaneously, and task difficulty was included as a covariate. The results based on 1,000 bootstrap samples showed that in all three exposure conditions (early, late, and none), the bootstrap coefficients for the indirect effects of prompt on performance through fixation and idea pre-formation were not significant for any of the dependent variables because all confidence intervals included zero (see Table III for bootstrap coefficients and bias corrected confidence intervals). Therefore, the results of the mediation analyses did not support *Hypothesis 3*.

**TABLE III**

BOOTSTRAP COEFFICIENTS AND BIAS CORRECTED 95% CONFIDENCE COEFFICIENTS (IN BRACKETS) FOR INDIRECT EFFECTS OF PROMPT ON PERFORMANCE THROUGH FIXATION AND IDEA PRE-FORMATION IN EXPERIMENT 2

Dependent Variable	Exposure Condition					
	<u>None</u>		<u>Early</u>		<u>Late</u>	
	Fixation	Pre-formation	Fixation	Pre-formation	Fixation	Pre-formation
Idea Quantity	.06 [-.46, 1.41]	2.05 [-1.42, 6.47]	.06 [-.34, 1.26]	1.76 [-1.16, 6.74]	.06 [-.56, 1.58]	1.48 [-3.82, 8.61]
Average Originality	0.00 [-.16, .09]	.32 [-.09, .86]	0.00 [-.19, .11]	.19 [-.10, .55]	-.01 [-.25, .16]	.06 [-.48, .59]
Number of Highly Original Ideas	-.05 [-.87, .36]	.87 [-.02, 2.32]	-.05 [-.60, .34]	.89 [-.02, 2.08]	-.05 [-.65, .29]	.34 [-.87, 1.72]
Number of Semantic Categories	-.04 [-.48, .16]	.21 [-.67, 1.21]	-.02 [-.34, .09]	.44 [-.19, 1.32]	.01 [-.12, .29]	.67 [-.28, 1.90]

### **3.3 Discussion**

One goal of this experiment was to gain more evidence in support of the general notion that alternate uses and improvements brainstorming prompts should not be treated interchangeably because they differentially impact ideational performance. Consistent with the results of Experiment 1, alternate uses prompts led to lower idea quality (average originality and solution variety) compared to the improvements prompts. However, alternate uses also resulted in a greater number of ideas. These results suggest that the two prompts are not equivalent and may involve different cognitive processes.

Another goal of this experiment was to test more specific predictions about the effects of exposure to others' ideas in response to the two prompts (Hypothesis 2) and about the nature of the cognitive mechanisms that might help to explain performance differences between them (Hypothesis 3). These predictions were not supported. The effects of prompt on performance did not vary as a function of differential exposure to examples. In addition, the amount of experienced fixation during brainstorming and the extent of idea pre-formation did not mediate the relationship between prompt and performance, and this effect did not depend on exposure to others' ideas.



## 4. EXPERIMENT 3

One goal of this experiment was to gain more evidence to support the prediction that alternate uses and improvements prompts are not interchangeable and differentially affect performance in terms of idea quantity or quality. A further goal of this experiment was to test the hypothesis that alternate uses prompts may provide more opportunity for cognitive stimulation from other people's ideas using a real group setting. As in Experiments 1 and 2, participants brainstormed in response to either an alternate uses prompt or an improvements prompt, 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 the traditional interacting-nominal group comparison. This experiment also provided a second test of Hypotheses 2 and 3. *Hypothesis 2* predicts that exposure to others' ideas will be more beneficial when given alternate uses prompts than improvements prompts. *Hypothesis 3* predicts that the extent of fixation and idea pre-formation will mediate these relationships, but these effects will depend on the setting. For the nominal groups, alternate uses prompts will be associated with lower idea pre-formation and greater amount of fixation than improvements prompts, which will subsequently decrease performance. However, for the interacting groups, idea pre-formation and the amount of fixation will not mediate group performance.

### **4.1 Method**

#### **4.1.1 Design and participants**

This study employed a 2 question (alternate uses, improvements) x 2 group (nominal, interacting) between-subjects factorial design. Participants were randomly assigned to brainstorm for 20 minutes either on alternate uses for vehicles (such as cars, SUVs, and/or vans) or on ways

to improve these vehicles. 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 participants typed and exchanged their ideas with each other. In both conditions, ideas were typed into an instant messaging tool.

Participants in the proposed study were 252 undergraduate students (48% female) from the UIC Psychology Subject Pool. They participated for course credit to be applied toward their undergraduate research experience component of the grade for Introductory Psychology. The number of groups (all same-gender) in each of the four cells of the factorial design is reported in Table IV.

#### **4.1.2 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 explanation included background information on brainstorming, brainstorming rules, and EBS procedure. The brainstorming prompt manipulation was randomized across the two group setting conditions. Groups and individuals generated ideas either on other uses for cars, SUVs, and/or vans or on improvements to these vehicles. Appendices C and G detail the instructions that were given in each condition. Every participant received a printed copy of these 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 2, after five ideas, the list started to scroll so that only the most recent five ideas were visible in either condition.

The same final questionnaire was given as in Experiment 2, with the exception of additional items given in the interacting group condition, designed to gauge participants' impressions of working with others. See Appendix E for more detail.

### **4.1.3 Coding**

For this study, 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, Berry, & Block, 1958). The same coding process was used as developed in Experiment 2, and the same final set of dependent variables was computed for each interacting and nominal group. Specifically, each group's ideas were scored for the total number of non-redundant responses as an index of idea quantity, and three measures of quality were computed: average idea originality, number of highly original ideas, and number of categories sampled. As reported in Experiment 2, average idea quality and the number of high quality ideas were not computed due to very low inter-rater reliability on these measures.

#### *Scale Reliability*

As in Experiment 2, the three items on the final questionnaire intended to measure the extent of fixation during brainstorming showed an insufficient scale reliability (Cronbach's  $\alpha = .69$ ). The item "Some of my earlier ideas got in the way of generating new, additional ideas" did not correlate with the other two items and was dropped, increasing the alpha to an acceptable level of .74. The remaining two items were thus averaged to create a composite fixation score.

The three items on the final questionnaire intended to measure the extent of idea pre-formation also showed a low scale reliability (Cronbach's  $\alpha = .59$ ). Exclusion of any of the items did not significantly improve it. Therefore, the three items were analyzed separately. However, the results are reported for only a single item, "I have thought about/considered alternate uses/improvements to cars, SUVs, and/or vans before this experiment," as this was the only question that showed significant differences between the two prompts.

Finally, the two items on the final questionnaire assessing task difficulty were positively correlated ( $r(227) = .61, p < .05$ ), and thus averaged together (Cronbach's  $\alpha = .76$ ).

#### **4.1.4 Cases Dropped from Analyses**

A total of two hundred and fifty-two participants took part in this experiment, or 84 groups. Exploratory data analyses revealed two outliers that fell more than two standard deviations away from the mean on at least one of the dependent variables, and thus were dropped from all analyses. The first outlier was a nominal group in the alternate uses condition (outlier in the number of highly original responses), and the second one was an interacting group in the improvements condition (outlier in idea quantity). The data from the remaining 246 individuals, or 82 groups, was included in the analyses reported below.

### **4.2 Results**

#### **4.2.1 Effects of Brainstorming Prompt and Group Setting on Performance**

The first phase of analyses for Experiment 3 tested the general prediction that alternate uses and improvements prompts differentially affect ideational performance, as well as *Hypothesis 2*, which predicted that individuals will gain more from exposure to others' ideas when given alternate uses prompts than improvements prompts. Means and standard deviations

for each cell of the 2 (prompt: alternate uses, improvements) x 2 (setting: interacting, nominal)  
for each of the dependent variables reported below can be found in Table IV.

**TABLE IV**

MEANS AND STANDARD DEVIATIONS (IN PARENTHESES) FOR EACH CONDITION  
IN EXPERIMENT 3

Dependent variable	Alternate Uses		Improvements	
	<u>Interacting groups</u> (n = 22)	<u>Nominal groups</u> (n = 19)	<u>Interacting groups</u> (n = 23)	<u>Nominal groups</u> (n = 18)
Idea Quantity	75.14 (28.08)	76.21 (32.70)	57.39 (25.53)	79.61 (23.47)
Average Originality	94.95 (1.25)	94.72 (1.28)	95.69 (1.42)	96.01 (.89)
<sup>a</sup> Number of highly original ideas	16.68 (6.21)	13.89 (6.23)	18.47 (6.46)	18.02 (6.27)
<sup>a</sup> Number of semantic categories	18.69 (2.47)	19.13 (2.47)	17.48 (2.58)	20.19 (2.52)
Fixation	3.38 (.97)	3.71 (1.07)	3.15 (1.04)	3.38 (1.06)
Pre-formation	1.79 (1.00)	1.78 (1.09)	2.23 (1.24)	2.44 (1.25)
Difficulty	3.15 (.77)	3.57 (1.05)	3.09 (1.04)	2.24 (.90)

<sup>a</sup>Means and standard deviations are adjusted to control for the total number of responses.

#### **4.2.1.1 Idea Quantity**

One coder counted the total number of non-redundant ideas for all of the groups. A second coder scored 39 groups (48%) to establish inter-rater reliability on this variable, which was high, with single-measure intraclass correlation coefficient of .99. Data from the first coder were used in the analyses.

A 2 (prompt: alternate uses, improvements) x 2 (setting: interacting, nominal) between-subjects ANOVA with the total number of non-redundant ideas as the dependent variable revealed a marginally significant main effect of setting. Nominal groups generated more ideas ( $M = 77.86$ ,  $SD = 28.24$ ) than interacting ones ( $M = 66.07$ ,  $SD = 27.98$ ),  $F(1, 78) = 3.61$ ,  $p = .061$ . However, this main effect was qualified by a marginally significant interaction between prompt and setting,  $F(1, 78) = 2.97$ ,  $p = .089$ . As can be seen in Figure 2, planned follow-up tests showed that on the improvements prompt, nominal groups ( $M = 79.61$ ,  $SD = 23.47$ ) outperformed interacting ones ( $M = 57.39$ ,  $SD = 25.53$ ),  $F(1, 78) = 6.53$ ,  $p < .05$ . In contrast, there was no difference in the number of generated ideas between the two group types on the alternate uses prompt ( $M = 76.21$ ,  $SD = 32.70$  for the nominal and  $M = 75.14$ ,  $SD = 28.08$  for the interacting groups),  $F < 1$ .

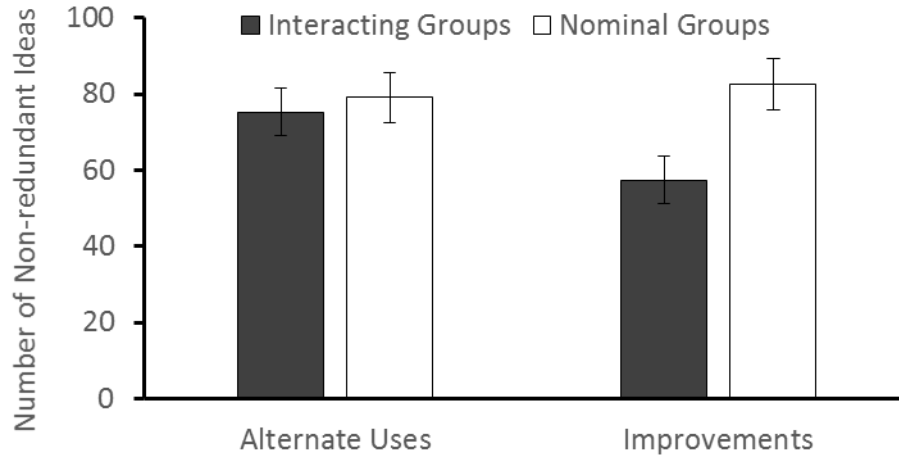


Figure 2. Total number of non-redundant ideas as a function of prompt and group type in Experiment 2.

#### **4.2.1.2 Average Idea Originality**

Average originality was calculated for each group's list of ideas based on the percentage of people in the combined sample for Experiments 2 and 3 who suggested each solution. The higher the percentage, the lower the originality of that idea. These percentages were then averaged for each group to control for the total number of generated ideas and subtracted from 100 to yield a measure of average idea originality.

The results of a 2 (prompt: alternate uses, improvements) x 2 (setting: interacting, nominal) between- subjects ANOVA on this dependent variable revealed only a main effect of prompt,  $F(1, 69) = 12.69, p < .05$ . Alternate uses prompts led to lower idea originality ( $M = 94.83, SD = 1.26$ ) than the improvements prompts ( $M = 95.84, SD = 1.20$ ).

#### **4.2.1.3 Average Idea Quality & Number of Highly Creative Responses**

As reported in the Results section of Experiment 2, the subjective assessment of idea quality resulted in a very low inter-rater reliability. Thus, no further computations or analyses were performed with this dependent variable.

#### **4.2.1.4 Number of Highly Original Responses**

The total number of unique ideas, or responses generated by a single person in the combined sample in the two experiments, was calculated for each group. A two-way ANOVA revealed a marginally significant interaction between prompt and setting,  $F(1, 75) = 3.31, p = .073$ . Follow-up analyses showed a similar pattern of results as with the total number of ideas. Specifically, given the improvements prompt, nominal groups came up with a marginally larger number of unique responses ( $M = 20.67, SD = 10.71$ ) than interacting groups ( $M = 14.05, SD = 10.73$ ),  $F(1, 75) = 3.98, p = .052$ . However, this productivity gap was eliminated in the alternate uses prompt condition ( $M = 15.61, SD = 9.89$  for the nominal and  $M = 17.57, SD = 10.36$  for the interacting groups),  $F < 1$ .

This analysis was repeated using an ANCOVA, with the number of unique responses as a dependent variable and the total number of ideas serving as a covariate. Controlling for the total number of ideas generated yielded only a marginally significant main effect of prompt,  $F(1, 74) = 4.16, p = .045$ . The improvements prompt resulted in a larger number of unique ideas ( $M = 18.25, SD = 6.33$ ) than the alternate uses prompt ( $M = 15.29, SD = 6.34$ ).

#### **4.2.1.5 Number of Semantic Categories Sampled**

Each idea in the group transcript was classified into one of 29 mutually exclusive categories for each of the two prompts. The principal investigator scored the entire data set for the number of semantic categories sampled at least once by each group. A 2 (prompt: alternate



uses, improvements) x 2 (setting: interacting, nominal) ANOVA revealed a significant main effect of setting, with nominal groups sampling from more categories ( $M = 20.36$ ,  $SD = 2.94$ ) than the interacting groups ( $M = 17.51$ ,  $SD = 4.72$ ),  $F(1, 77) = 10.53$ ,  $p < .05$ . However, there was also a significant interaction between prompt and setting,  $F(1, 77) = 6.67$ ,  $p < .05$ . Follow-up analyses indicated that given the improvements prompt, nominal groups sampled more categories ( $M = 21.06$ ,  $SD = 2.71$ ) than the interacting ones ( $M = 16.00$ ,  $SD = 4.95$ ),  $F(1, 77) = 17.15$ ,  $p < .05$ . However, given the alternate uses prompt, interacting and nominal groups performed equally well ( $M = 19.67$ ,  $SD = 3.07$  for the nominal and  $M = 19.09$ ,  $SD = 4.00$  for the interacting groups),  $F < 1$ .

This analysis was repeated with an ANCOVA, using the number of categories as the dependent variable and the total number of ideas as a covariate. The results of this analysis revealed a similar pattern of findings as without the covariate. Specifically, there was a significant main effect of setting, with nominal groups sampling from more categories ( $M = 19.66$ ,  $SD = 2.54$ ), on average, than the interacting groups ( $M = 18.09$ ,  $SD = 2.54$ ),  $F(1, 76) = 7.26$ ,  $p < .05$ . However, it was qualified by a marginally significant interaction between prompt and setting,  $F(1, 76) = 3.85$ ,  $p = .053$ . Given the improvements prompt, nominal groups sampled from more categories ( $M = 20.19$ ,  $SD = 2.49$ ) than the interacting ones ( $M = 17.48$ ,  $SD = 2.58$ ),  $F(1, 76) = 5.61$ ,  $p < .05$ . However, given the alternate uses prompt, there was no difference between the two group types ( $M = 19.13$ ,  $SD = 2.48$  for the nominal and  $M = 18.69$ ,  $SD = 2.49$  for the interacting groups),  $F < 1$ .

In sum, the results provide additional support to the general prediction that alternate uses and improvements prompts differentially affect ideational performance. In addition, the results of this experiment supported *Hypothesis 2*, predicting 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 (number of highly original responses and number of semantic categories) than the nominal groups, but this gap was eliminated when they brainstormed about alternate uses for vehicles.

#### **4.2.2 Self-report Measures**

Results from the self-report measure of experienced fixation assessed in the final survey revealed a significant main effect of prompt,  $F(1, 225) = 4.23, p < .05$ . Participants brainstorming in response to the alternate uses prompts reported more fixation than those brainstorming in response to the improvements prompt (see Table IV for means and standard deviations). In addition, there was a marginally significant effect of setting, with the nominal groups reporting more fixation than the interacting groups,  $F(1, 225) = 4.01, p = .046$ . There was also a significant effect of prompt on idea pre-formation,  $F(1, 225) = 13.07, p < .05$ . Brainstormers reported having thought more about improvements than other uses for vehicles prior to the study. Finally, there was a significant effect of setting on task difficulty,  $F(1, 225) = 5.26, p < .05$ . Members of nominal groups found the brainstorming task more challenging compared to members of interacting groups.

#### **4.2.3 Mediating Role of Fixation and Idea Pre-formation**

The third phase of analyses was performed to test *Hypothesis 3*, that idea pre-formation and the amount of fixation will mediate the effects of group setting and brainstorming prompts on performance. It was predicted that for the nominal groups, alternate uses prompts would be associated with lower idea pre-formation and greater fixation than improvements prompts, which

would subsequently decrease performance. However, for the interacting groups, idea pre-formation and fixation would not mediate group performance.

I employed the bootstrapping strategy recommended by Hayes (2009, 2013, Model 14) to test the moderated mediation model suggested by this hypothesis, as in Experiment 2. Four separate moderated mediation analyses were performed, one for each dependent variable: idea quantity, average idea originality, number of highly original responses, and number of semantic categories. The two mediators (fixation and idea pre-formation) were entered simultaneously, and task difficulty was included as a covariate. Fixation was based on the composite score from two self-report items on the final questionnaire, and idea pre-formation was indexed by a single item, “I have thought about improvements/other uses for cars, SUVs, and/or vans before this experiment.” Both mediator variables were assessed at the level of the individual, but performance at the level of the group. To solve this level of analysis issue the group performance score was assigned to every group member.

The results based on 1,000 bootstrap samples showed that for both nominal and interacting groups, the bootstrap coefficients for the indirect effects of prompt on performance through fixation and idea pre-formation were not significant for any of the dependent variables because all confidence intervals included zero (see Table V for bootstrap coefficients and bias corrected confidence intervals). Therefore, the results of the mediation analyses did not support *Hypothesis 3*.

**TABLE V**

BOOTSTRAP COEFFICIENTS AND BIAS CORRECTED 95% CONFIDENCE INTERVALS (IN BRACKETS) FOR INDIRECT EFFECTS OF PROMPT ON PERFORMANCE THROUGH FIXATION AND IDEA PRE-FORMATIONB IN EXPERIMENT 3

Dependent Variable	<u>Nominal Groups</u>		<u>Interacting Groups</u>	
	Fixation	Pre-formation	Fixation	Pre-formation
Idea quantity	1.06 [-.06, 4.43]	2.23 [-.41, 6.62]	-.47 [-2.85, .22]	1.22 [-.87, 4.11]
Average Originality	.02 [-.02, .14]	.02 [-.10, .16]	-.01 [-.09, .02]	.06 [-.03, .18]
Number of Highly Original Ideas	.40 [-.06, 1.74]	.53 [-.43, 2.11]	-.20 [-1.16, .07]	.70 [-.08, 2.10]
Number of semantic categories	.11 [-.01, .40]	.42 [-.12, 1.00]	-.10 [-.43, .02]	.18 [-.13, .59]

### **4.3 Discussion**

One goal of Experiment 3 was to gain more evidence in support of the notion that alternate uses and improvements prompts differentially affect ideational performance. A further goal of Experiment 3 was to test the hypothesis that alternate uses prompts provide more opportunity for cognitive stimulation from other people's ideas using a real group setting. Consistent with Experiments 1 and 2, support was found for general prediction that the alternate uses and improvements prompts differentially affect brainstorming performance. Further, using real groups, I also found support for *Hypothesis 2*, which predicted more benefits of cognitive stimulation on the alternate uses compared to the improvements prompt in the quantity and

quality of ideas. The results were consistent with the well-documented process loss that has been observed in studies using improvements prompts for brainstorming (Larson, 2010; Mullen, Johnson, & Salas, 1995). In contrast, 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) 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.

Research also suggests that people enjoy brainstorming in groups (reviewed in Larson, 2010), a finding that was supported in this experiment as well. Members of the interacting groups reported marginally higher task satisfaction ( $M = 3.67$ ,  $SD = .95$ ) than individuals in nominal groups ( $M = 3.42$ ,  $SD = .95$ ),  $F(1, 225) = 3.99$ ,  $p = .047$ . Since groups and teams are utilized in virtually every organizational domain, identifying the conditions that prevent productivity loss in group settings is a worthwhile endeavor. The results of this experiment suggest that idea generation prompts that challenge brainstormers to think of new uses for objects or places may not result in performance detriments when done in groups, in contrast to the brainstorming questions that call for improvements to objects, places, or procedures.

Another goal of this experiment was to test *Hypothesis 3*, predicting that the amount of fixation and the extent of idea pre-formation would mediate the relationship between prompt and performance, and that this indirect effect would be moderated by group setting. This moderated mediation hypothesis was not supported, and neither was the simpler mediation model.

## 5. 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 observing benefits of cognitive stimulation in brainstorming groups. One question addressed was whether alternate uses and improvements brainstorming prompts differentially affect performance, in terms of both idea quantity and quality. Another question addressed was which type of brainstorming prompt (if any) might be more conducive to reaping the benefits of idea exchanges in groups. It was predicted that individuals would experience more fixation when given alternate uses prompts than improvements prompts (*Hypothesis 1*). As a result, more benefits of cognitive stimulation (i.e. being exposed to the ideas of others) would be seen with alternate uses prompts than improvements prompts (*Hypothesis 2*). Finally, it was predicted that the amount of fixation and extent of idea pre-formation would mediate the relationship between prompt type and ideational performance, and that this pathway would be moderated by cognitive stimulation condition/group type (*Hypothesis 3*).

These hypotheses were tested in a series of three experiments. In Experiment 1, individuals generated ideas using alternate uses or improvements prompts to cars, SUVs, and/or vans. Experiment 2 addressed whether exposure to other people's ideas differentially influenced performance in response to these prompts. The timing of exposure to others' ideas (early, late, or none) was varied. In Experiment 3, participants brainstormed in response to one of the two prompts in either an interactive group setting (exchanging ideas with others) or individually (no idea sharing).

Evidence in support of the general prediction that the alternate uses and improvements brainstorming questions are not equivalent and differentially affect ideational performance was found in all three experiments. The results of Experiment 1 and 2 suggest that alternate uses prompts lead to lower idea quality among individuals, such as lower average originality and fewer highly original solutions. In addition, in Experiment 3, alternate uses prompts resulted in lower idea variety than the improvements prompts. Taken together, these results suggest that the two brainstorming prompts are not equivalent and should not be treated interchangeably in the literature.

*Hypothesis 1* predicted greater fixation on the alternate uses prompts among individuals and received mixed support. Initial empirical evidence in support of this hypothesis was obtained in Experiment 1 as those who brainstormed about other uses for cars reported more interference from their own earlier generated ideas than those who brainstormed about improvements to these vehicles. In addition, it was found in Experiment 2 that alternate uses prompts resulted in lower idea variety, suggesting more fixation when give these prompts. However, no differences between the two prompts were found using self-report measures of fixation in Experiments 2 and 3.

*Hypothesis 2* predicted more benefits of cognitive stimulation (exposure to others' ideas) on the alternate uses compared to the improvements prompts. This hypothesis received support in Experiment 3, but not in Experiment 2. Specifically, interacting groups showed a detriment in both idea quantity and quality when given the improvements prompt, but this "process loss" was eliminated when given the alternate uses prompts, supporting the notion of benefits of idea sharing on the latter prompt. This result suggests that the idea 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 in this research suggest that benefits of idea sharing are more likely to be found on the alternate uses prompts. The results also support the notion that one of the reasons contributing to the finding of group synergy in the study by Paulus and Yang (2000) could be because unlike most other research on the topic, they used an alternate uses prompt (other uses for a paper clip).

Failure to find benefits of exposure to others' ideas on the alternate uses prompt in Experiment 2 could be due to several reasons. First, in both the early and late exposure conditions individuals were presented with a pre-selected list of only four ideas, possibly an insufficient number to provide cognitive stimulation. Moreover, only one of four stimulus ideas for each prompt was of high quality. Second, when presented with others' ideas after having the chance to brainstorm on your own, as was done in the late exposure condition, participants may have already generated at least some of the provided examples, and thus did not find them helpful. Third, the stimulus ideas were presented simultaneously at a fixed time, not when participants actually expressed the need for external stimulation. This limitation could be addressed in future research by presenting stimulus ideas only when brainstormers show evidence of insufficient progress, such as a lack of response submission for a given period of time.

It is noteworthy to point out that although the interaction between prompt and setting on the number of highly original responses in Experiment 3 was no longer significant after controlling for idea quantity, it takes only one or several highly creative ideas implemented successfully to achieve innovation. A large number of ideas and high average creativity of responses is only an intermediary, not the ultimate goal of brainstorming. The end goal is to



select for a successful implementation one or few highly creative solutions discovered during brainstorming. Thus, if the list of brainstormed ideas includes at least one such response, this ought to be the benchmark for judging the success of a brainstorming session, and identifying conditions that promote the likelihood of generation of at least one highly creative idea is a worthwhile endeavor.

*Hypothesis 3* predicted that the amount of fixation and the extent of idea pre-formation would mediate the relationship between prompt and performance, and that this indirect effect would be moderated by cognitive stimulation/group setting. This moderated mediation hypothesis was tested in both Experiment 2 and 3 and was not supported. A major limitation in testing this prediction was that the mediating constructs were assessed using self-report measures that failed to yield reliable constructs. For example, three questions on the final questionnaire were designed to tap into the amount of fixation individuals experienced. However, a composite fixation score was computed using only two of them since one of the items did not correlate with the other two. In addition, none of the three items designed to assess idea pre-formation correlated with each other, and thus, mediation analyses were based on a single question. Therefore, in future research substantially more items might need to be included in self-report assessment of fixation and idea pre-formation or more objective measures of these constructs.

Another direction for future research could be to manipulate fixation by having participants begin the brainstorming session after they have reached an impasse. For example, one could include a comparison condition where participants brainstorm individually and report having reached an impasse before they start a group brainstorming session. If overcoming fixation on the alternate uses prompts is a significant factor in reaping the benefits of cognitive

stimulation in groups, more benefits of group interaction would be observed on the alternate uses compared to the improvements prompt.

One of the strengths of this research is that measures of both idea quantity and quality were utilized to assess individual and group ideational performance. Although the number of responses is often correlated with the number of highly creative responses (Reinig, Briggs, & Nunamaker, 2007), as was also the case in this research, idea variety assessed via the number of sampled semantic categories in Experiment 3 yielded significant results even after controlling for the total number of generated responses. This suggests that including measures of both idea quantity and quality in idea generation research can offer unique insights to understanding the generation process and performance in group settings.

However, so far only the more objective measures of idea quality from these experiments have been analyzed. Low inter-rater reliability among the three trained raters using the Silvia et al. (2008) Subjective Assessment Technique suggested that this method is scoring was problematic. Raters differed greatly in what is creative despite providing them with a specific definition of creativity. Because of the issues identified with using expert raters and to have consistency creativity measurement among all three experiments, two alternative scoring methods are in progress. The first is to use creativity ratings from thirty Subject Pool participants to obtain consensus scores for Experiments 2 and 3, as was done in Experiment 1. Since it proved difficult to attain agreement on what is creative with a just a handful of raters, it might be more worthwhile to judge creativity based on consensus among a large number of people (Amabile, 1982). A further step to improve consistency is to compute intraclass correlation coefficients for creativity ratings obtained using this scoring method in Experiment 1. The second ongoing line of coding is using the automatic scoring tool Latent Semantic Analysis (e.g.,

Forster & Dunbar, 2009). The third line of analysis that is still in progress is exploring timing of ideas and whether differences may be seen between the prompts early versus late in the brainstorming session.

### **5.1 Conclusion**

This research represents an attempt to directly investigate the effects of the brainstorming question on individual and group ideational performance. Questions that prompt brainstormers to consider multiple uses for common objects and questions that call for improvements to objects or places have been presumed to be equivalent in past brainstorming research. However, the results of the present studies suggest that alternate uses and improvements prompts differentially affect ideational performance, and thus should not be treated interchangeably. Importantly, the findings also provide initial evidence to the idea that alternate uses questions are more conducive to reaping the benefits of cognitive stimulation provided by idea exchanges in group settings. This notion is consistent with the famous finding of synergy in the group brainstorming literature (Paulus & Yang, 2000). Although no group synergy was observed in the present research, the closing of the interacting-nominal group performance gap on the alternate uses prompt is a substantial contribution to research and practice. However, additional research is needed to understand cognitive and social mechanisms involved in the relationship between prompt and ideational performance.

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## 7. APPENDICES

### Appendix A Questionnaire – Experiment 1

Brainstorming about cars and/or vans was important to me.

1	2	3	4	5
Strongly Disagree				Strongly Agree

I think the brainstorming topic was interesting.

1	2	3	4	5
Strongly Disagree				Strongly Agree

I enjoyed working on this task.

1	2	3	4	5
Strongly Disagree				Strongly Agree

I have put in a considerable amount of effort while brainstorming.

1	2	3	4	5
Strongly Disagree				Strongly Agree

It was difficult for me to keep generating new, additional ideas.

1	2	3	4	5
Strongly Disagree				Strongly Agree

I often felt like I was “stuck” while brainstorming.

1	2	3	4	5
Strongly Disagree				Strongly Agree

Some of my earlier ideas got in the way of generating new, later ideas.

1 2 3 4 5

Strongly Disagree

Strongly Agree

I enjoyed working alone on this task.

1 2 3 4 5

Strongly Disagree

Strongly Agree

It would have been easier to brainstorm with a partner.

1 2 3 4 5

Strongly Disagree

Strongly Agree

I wrote all of the ideas that came to mind.

1 2 3 4 5

Strongly Disagree

Strongly Agree

I have thought about/considered ideas about cars, SUVs, and/or vans before this experiment.

1 2 3 4 5

Strongly Disagree

Strongly Agree

When I brainstormed, many of my ideas were already in the mind, I just had to recall them.

1 2 3 4 5

Strongly Disagree

Strongly Agree

How creative of an individual do you consider yourself to be?

1 2 3 4 5

Not at all Creative

Very Creative

## Appendix B

### Creativity Rating Instructions

Your task for today is to rate the creativity of a set of answers to the question “What are creative ways to improve cars, SUVs and/or vans?” OR “What are other uses for cars, SUVs and/or vans?”

Before scoring the creativity of each answer, you will first read over the list of responses. After you finish reading all of the ideas, you will then rate the creativity of each idea.

#### HOW TO SCORE CREATIVITY

Creative ideas can be viewed as having THREE properties: uncommonness, remoteness and cleverness. Creative responses will generally be high on all three, although being low on one of them does not disqualify a response from getting a high rating. You will use a 1 (*not at all creative*) to 5 (*highly creative*) scale to rate creativity using these criteria.

##### 1. Uncommonness

Creative ideas are often uncommon. Any response that you think would be likely to be given by a lot of people is common, and should be judged as less creative.

##### 2. Remoteness

Creative ideas are often remotely linked to the everyday or typical improvements to/uses for objects. For example, creative improvements/uses for cars are “far from” common, everyday, normal improvements/uses for cars. Responses that stray from obvious ideas should be judged as more creative, whereas responses close to obvious ideas should be judged as less creative.

##### 3. Cleverness

Creative ideas are often clever. They strike people as insightful, ironic, humorous, and smart, but also fitting and appropriate. Responses that seem clever should be judged as more creative than responses that seem less clever. Keep in mind that cleverness can compensate for the other facets. For example, a common improvement/use cleverly expressed could receive a high score.

## Appendix C

### Brainstorming Instructions for Individuals

*Italicized font*: early exposure condition only

Underlined font: late exposure condition only

Brainstorming is a technique that is used to facilitate the flow of ideas. It is widely used in a large number of U.S. corporations, and is generally used when new, unique, original, and creative ideas are desired. The procedure is relatively straightforward and easy to understand. Listed below are the brainstorming rules. We want you to apply these rules as best as you can while you work individually.

#### Brainstorming Rules:

- 1) Criticism is ruled out. Adverse judgment of ideas must be withheld. Do not criticize your own ideas. Write everything that you think of.
- 2) Freewheeling is welcome. The wilder the idea, the better. It is easier to tame down an idea than to think up. Don't be afraid to write anything that comes to mind. The farther out the idea, the better. This will stimulate more and better ideas.
- 3) Quantity is wanted. The greater the number of ideas, the more the likelihood of winners. Come up with as many ideas as you can.
- 4) Combination and Improvement are sought. You should try to suggest how ideas can be joined into still better ideas. Don't be afraid to combine and improve ideas.

#### DO YOU HAVE ANY QUESTIONS?

#### Brainstorming Procedure:

- Each of you will be seated at a separate computer terminal in separate rooms. You will all work individually.
- You will type all of your ideas on the computer by using the Google Talk tool.
- Your ideas will be transmitted to the administrator's computer.
- You do not need to make complete sentences when typing the ideas. Just use simple phrases.
- Don't worry about spelling or grammar.

#### DO YOU HAVE ANY QUESTIONS?

#### Brainstorming Question (will vary by prompt condition):

What are some ways to use cars, SUVs, and/or vans **OTHER** than for transportation? OR  
What are some ways to improve cars, SUVs, and/or vans?

*For example, some of the previous participants in the study came up with following ideas:*

*use cars for sleeping, to listen to the music, for storage, and use parts of a car to build a robot OR improve fuel economy, increase the size, make cars safer, and make vehicles that run on water.*

Instructions to be given after 10 minutes of brainstorming (Experiment 2 only):

Please stop writing and take a minute to fill out this brief survey to let us know about your progress (Impasse questionnaire). You may continue brainstorming after you are finished.

To help you with your progress, here are a couple of examples that previous participants: use cars for sleeping, to listen to the music, for storage, and use parts of a car to build a robot OR improve fuel economy, increase the size, make cars safer, and make vehicles that run on water. You may now continue brainstorming.

## Appendix D

### Impasse Questionnaire – Experiment 2

**Please answer the following questions honestly to let us know about your brainstorming progress.**

At this time, I cannot think of any new ideas.

1	2	3	4	5
Strongly Disagree				Strongly Agree

I feel like I am “stuck.”

1	2	3	4	5
Strongly Disagree				Strongly Agree

I can easily keep generating additional ideas.

1	2	3	4	5
Strongly Disagree				Strongly Agree

At this time, it would be helpful to hear the ideas of other people.

1	2	3	4	5
Strongly Disagree				Strongly Agree

## Appendix E

### Final Questionnaire – Experiments 2 and 3

**Bold font:** group conditions only

***Bold and italicized font:*** group and exposure conditions only

(Text in parentheses): exposure conditions only

1. Brainstorming about this topic was important to me.

1	2	3	4	5
Strongly Disagree			Strongly Agree	

2. I think the brainstorming question was interesting.

1	2	3	4	5
Strongly Disagree			Strongly Agree	

3. I enjoyed working on this task.

1	2	3	4	5
Strongly Disagree			Strongly Agree	

4. I have put in a considerable amount of effort while brainstorming.

1	2	3	4	5
Strongly Disagree			Strongly Agree	

5. The brainstorming task was challenging for me.

1	2	3	4	5
Strongly Disagree			Strongly Agree	

6. It was difficult for me to keep generating new, additional ideas.

1	2	3	4	5
Strongly Disagree			Strongly Agree	

7. I often felt like I was “stuck” while brainstorming.

1                      2                      3                      4                      5

Strongly Disagree

Strongly Agree

8. Some of my earlier ideas got in the way of generating new, later ideas.

1                      2                      3                      4                      5

Strongly Disagree

Strongly Agree

9. There were many times when I could not come up with a new idea for more than one minute.

1                      2                      3                      4                      5

Strongly Disagree

Strongly Agree

10. I enjoyed working alone on this task.

1                      2                      3                      4                      5

Strongly Disagree

Strongly Agree

11. It would have been easier to brainstorm with other people.

1                      2                      3                      4                      5

Strongly Disagree

Strongly Agree

12. I/our group came up with many ideas on this topic.

1                      2                      3                      4                      5

Strongly Disagree

Strongly Agree

13. I/our group came up with high quality ideas on this topic.

1                      2                      3                      4                      5



Strongly Disagree

Strongly Agree

14. I wrote all of the ideas that came to mind.

1

2

3

4

5

Strongly Disagree

Strongly Agree

15. I did not express some of my ideas because they seemed foolish.

1

2

3

4

5

Strongly Disagree

Strongly Agree

16. I have thought about/considered improvements to/other uses for cars, SUVs, and/or vans before this experiment.

1

2

3

4

5

Strongly Disagree

Strongly Agree

17. When I brainstormed, some of my ideas were already in mind, I just had to write them down.

1

2

3

4

5

Strongly Disagree

Strongly Agree

18. When I first heard about the brainstorming topic, I could think of many ideas right away.

1

2

3

4

5

Strongly Disagree

Strongly Agree

***19. Sometimes, (examples of) other people's ideas got in the way of me coming up with my own ideas.***

<i><b>1</b></i>	<i><b>2</b></i>	<i><b>3</b></i>	<i><b>4</b></i>	<i><b>5</b></i>
<i><b>Strongly Disagree</b></i>			<i><b>Strongly Agree</b></i>	

20. (Examples of) other people's ideas were distracting.

<i><b>1</b></i>	<i><b>2</b></i>	<i><b>3</b></i>	<i><b>4</b></i>	<i><b>5</b></i>
<i><b>Strongly Disagree</b></i>			<i><b>Strongly Agree</b></i>	

21. (Examples of) other people's ideas were helpful.

<i><b>1</b></i>	<i><b>2</b></i>	<i><b>3</b></i>	<i><b>4</b></i>	<i><b>5</b></i>
<i><b>Strongly Disagree</b></i>			<i><b>Strongly Agree</b></i>	

22. (Examples of) other people's ideas helped me come up with additional ideas when I was stuck.

<i><b>1</b></i>	<i><b>2</b></i>	<i><b>3</b></i>	<i><b>4</b></i>	<i><b>5</b></i>
<i><b>Strongly Disagree</b></i>			<i><b>Strongly Agree</b></i>	

23. I enjoyed working with other people on this task.

<i><b>1</b></i>	<i><b>2</b></i>	<i><b>3</b></i>	<i><b>4</b></i>	<i><b>5</b></i>
<i><b>Strongly Disagree</b></i>			<i><b>Strongly Agree</b></i>	

24. It would have been easier to brainstorm alone.

<i><b>1</b></i>	<i><b>2</b></i>	<i><b>3</b></i>	<i><b>4</b></i>	<i><b>5</b></i>
<i><b>Strongly Disagree</b></i>			<i><b>Strongly Agree</b></i>	

25. I had a good, productive interaction with my partners.

<i><b>1</b></i>	<i><b>2</b></i>	<i><b>3</b></i>	<i><b>4</b></i>	<i><b>5</b></i>
<i><b>Strongly Disagree</b></i>			<i><b>Strongly Agree</b></i>	

**26. I liked my partners.**

**1**

**2**

**3**

**4**

**5**

**Strongly Disagree**

**Strongly Agree**

**27. I did not express some of my ideas because I did not know what my partners would think of them.**

**1**

**2**

**3**

**4**

**5**

**Strongly Disagree**

**Strongly Agree**

**28. How creative of an individual do you consider yourself to be?**

**1**

**2**

**3**

**4**

**5**

**Not at all Creative**

**Very Creative**

**29. What is your gender? Circle one.**

**Male**

**Female**

## Appendix F

### 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 (kids playground, kids 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 heaving things, ladder)
- P. Teaching/training/testing purposes (experiments, teach in 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, back up 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

## Appendix G

### Brainstorming Instructions for Interacting Groups

Brainstorming is a technique that is used to facilitate the flow of ideas. It is widely used in a large number of U.S. corporations, and is generally used when new, unique, original, and creative ideas are desired. The procedure is relatively straightforward and easy to understand. Listed below are the brainstorming rules. We want you to apply these rules as best as you can while you work as a group.

#### Brainstorming Rules:

- 1) Criticism is ruled out. Adverse judgment of ideas must be withheld. Do not criticize each other's ideas. Write everything that you think of.
- 2) Freewheeling is welcome. The wilder the idea, the better. It is easier to tame down an idea than to think up. Don't be afraid to write anything that comes to mind. The farther out the idea, the better. This will stimulate more and better ideas.
- 3) Quantity is wanted. The greater the number of ideas, the more the likelihood of winners. Come up with as many ideas as you can.
- 4) Combination and Improvement are sought. You should try to suggest how ideas can be joined into still better ideas. Don't be afraid to combine and improve ideas.

DO YOU HAVE ANY QUESTIONS?

#### Brainstorming Procedure:

- Each of you will be seated at a separate computer terminal in separate rooms. You will type your ideas on that computer. You will exchange ideas with your partners by using Google Talk. So you will type your ideas directly in Google Talk.
- Your conversation will be transmitted to the administrator's computer.
- Focus on brainstorming ideas and avoid extraneous conversations.
- You do not need to make complete sentences when typing the ideas. Just use simple phrases.
- Don't worry about spelling or grammar.

DO YOU HAVE ANY QUESTIONS??

#### Brainstorming Question (will vary by question condition):

What are some ways to use cars, SUVs, and/or vans OTHER than for transportation? **OR**

The brainstorming question is: What are some ways to improve cars, SUVs, and/or vans?

**HUMAN SUBJECTS COMMITTEE PROTOCOL APPROVAL**

This research was approved by the University of Illinois Human Subjects Institutional Review Board under protocol 2001-0489.



## 8. CURRICULUM VITAE

### Olga Goldenberg

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 Department of Psychology (M/C 285)  
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### Education:

**University of Illinois at Chicago** (August, 2007 – present)

Ph.D. in Psychology – expected December, 2014

Major: Social Psychology

Minor: Statistics, Methods, and Measurement

M.A. in Psychology – December, 2010

Faculty Advisors: James R. Larson, Jr., Jennifer Wiley

**Loyola University Chicago** (August, 2002 – May, 2006)

B.S., Summa Cum Laude

Major: Biology

Minor: Psychology

### Research Interests:

I am interested in group processes and group performance, with a particular emphasis on how group performance compares to that of individuals in the domain of creativity. I seek answers to questions such as what cognitive and behavioral factors are involved in enhancing individual and group-level creativity, and under what conditions groups might outperform individuals on tasks that involve creative thinking. In addition, I am also interested in the effects of collaboration on learning and performance.

### Publications:

**Goldenberg, O.**, Larson, J. R., Jr., & Wiley, J. (2013). Goal instructions, response format, and idea generation in groups. *Small Group Research*, 44, 227-256.

Wiley, J., **Goldenberg, O.**, Jarosz, A. F., Wiedmann, M. & Rummel, N. (2013). Diversity, collaboration, and learning by invention. *Proceedings of the 35th Annual Conference of the Cognitive Science Society*, 3765-3770, Austin, TX: Cognitive Science Society.

**Goldenberg, O., & Wiley, J. (2011)** Quality, conformity, and conflict: Questioning the assumptions of Osborn's Brainstorming technique. *Journal of Problem Solving*, 3, 96-118.

### **Manuscript under review:**

Jarosz, A. F., **Goldenberg, O.**, & Wiley, J. (under review). Learning by invention: Small group discussions that support learning in statistics. *Discourse Processes*.

### **Manuscripts in preparation:**

**Goldenberg, O.**, & Wiley, J. (in preparation). Individual and Group brainstorming: Does the question matter?

**Goldenberg, O.**, & Wiley, J. (in preparation). The role of positive affect in creative structure-building task in groups.

### **Conference Presentations:**

**Goldenberg, O.**, & Wiley, J. (2014, May). *Effects of alternate uses and improvements prompts on fixation during brainstorming*. Paper presented at the annual meeting of Midwestern Psychological Association, Chicago, IL.

Jarosz, A., F., **Goldenberg, O.**, & Wiley, J. (2014, August). *Learning by invention: Small group discussions that support learning in statistics*. Paper presented at the annual meeting of the Society for Text & Discourse, Chicago, IL.

Wiley, J., **Goldenberg, O.**, Jarosz, A. F., Wiedmann, M. & Rummel, N. (2013, August). *Diversity, collaboration, and learning by invention*. Poster presented at the 35th Annual Conference of the Cognitive Science Society, Berlin, DE.

**Goldenberg, O.**, & Wiley, J. (2013, July). *Learning by Invention in Diverse Groups: The Role of Leader Expertise*. Paper presented at the annual meeting of the Interdisciplinary Network for Group Research, Atlanta, GA.

**Goldenberg, O.**, Larson, J. R., Jr., & Wiley, J. (2012, July). *Goal Instructions, Response Format, and Idea Generation in Groups*. Poster presented at the annual meeting of the Interdisciplinary Network for Group Research, Chicago, IL.

**Goldenberg, O.**, & Larson, J. R., Jr. (2011, May). *Goal Instructions and Idea Generation in Groups*. Talk presented at the annual meeting of Midwestern Psychological Association, Chicago, IL.

**Goldenberg, O.** (2010, April). *The Quality of Group and Individual Creative Performance*. Poster presented at the annual meeting of Midwestern Psychological Association, Chicago, IL.

### **Professional Memberships:**

Interdisciplinary Network for Group Research member  
 Society for Personality and Social Psychology member  
 Association for Psychological Science member  
 Midwestern Psychological Association member

### **Ad-Hoc Reviewer:**

Human Factors  
 Group Processes & Intergroup Relations  
 Psychonomic Bulletin & Review  
 Behavior Research Methods  
 Basic and Applied Social Psychology  
 Society for Text and Discourse  
 Journal of Problem Solving

### **Honors and Awards:**

Phi Kappa Phi Honor Society member (2012)  
 Phi Beta Kappa National Honor Society member (2005)  
 Loyola University Gear-Up Tuition Award

### **Undergraduate Mentoring:**

Dominique Casey (Summer – Fall 2014) Idea quality coding in group brainstorming research  
 Alvin Kudilil (Summer 2014) Idea quality coding in group brainstorming research  
 Priya Patel (Summer 2014) Idea quality coding in group brainstorming research  
 Sebastian Perez (Spring 2014) Idea quality coding in group brainstorming research  
 Neelam Patel (Fall 2013 – Spring 2014) Effects of question on group brainstorming  
 Jugal Doshi (Fall 2013 – Spring 2014) Effects of question on group brainstorming  
 Sandra Tarasiewicz (Fall 2013) Effects of question on group brainstorming  
 Ripal Patel (Summer 2013) Learning by Invention in Groups  
 Matthew Cavers (Fall 2012 – Spring 2013) Idea generation prompt and brainstorming  
 Sabrin Jaber (Spring 2013) Idea generation prompt and brainstorming  
 Robert Hickson (Spring 2011) The effect of paper size on fixation in brainwriting  
 Michelle Thorstad (Spring 2011) The effect of paper size on fixation in brainwriting  
 Kelly Currier (Spring 2011) The effect of paper size on fixation in brainwriting  
 Kamila Baczek (Fall 2009 - Summer 2010) Creativity in group brainstorming  
 Michelle Weissman (Spring 2010 – Summer 2010) Creativity in group brainstorming

### **Teaching Experience:**

**Instructor**, University of Illinois at Chicago (overall ratings > 4/5)  
 Spring 2013, Statistical Methods in Behavioral Sciences  
 Summer 2013, Statistical Methods in Behavioral Sciences

Fall 2013, Statistical Methods in Behavioral Sciences  
 Spring 2014, Statistical Methods in Behavioral Sciences

**Lead Graduate Teaching Assistant**, University of Illinois at Chicago  
 Fall 2009, Introduction to Psychology

**Graduate Teaching Assistant**, University of Illinois at Chicago  
 Fall 2007 – Summer 2008, Introduction to Psychology  
 Summer 2009 – 2011, Social Psychology  
 Spring 2009 - 2010, Industrial and Organization Psychology  
 Fall 2010 – Spring 2013, Laboratory in Social Psychology

### **Teaching Interests:**

#### Undergraduate courses:

Introductory/General Psychology  
 Research Methods  
 Statistical Methods in Psychology  
 Social Psychology  
 Laboratory in Social Psychology  
 Creativity and Innovation

#### Graduate courses:

Social and Personality Psychology Seminar  
 Creativity and Innovation Seminar  
 Introduction to Statistical Analysis

### **References:**

Jennifer Wiley, Ph.D., Professor, University of Illinois at Chicago  
 James R. Larson, Jr., Ph.D., Professor and Chair, Loyola University Chicago  
 Linda J. Skitka, Ph.D., Professor and Associate Head, University of Illinois at Chicago  
 Gary E. Raney, Ph.D., Professor, University of Illinois at Chicago