

AN EXAMINATION OF FIXATION IN BRAINSTORMING

A Dissertation

by

NICHOLAS WILLIAM KOHN

Submitted to the Office of Graduate Studies of  
Texas A&M University  
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2008

Major Subject: Psychology

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## ABSTRACT

An Examination of Fixation in Brainstorming. (August 2008)

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In this dissertation, two areas of creativity are reviewed. “Fixation” refers to the inability to solve a problem or retrieve a memory due to prior experience or an inappropriate solution path. Brainstorming is the process of generating as many possible ideas on a topic as possible. From this synthesis, it was hypothesized that fixation occurs in brainstorming. Three experiments tested the predictions of this theory. It was revealed that the exchanging of ideas in a group setting leads to members exploring fewer domains of ideas. Through a controlled setting, it was also found that people conform their ideas to ideas suggested by others. The last experiment tested incubation as a mechanism by which to reduce fixation in brainstorming. Findings were mixed but show that taking breaks can be effective in increasing brainstorming efficiency.

The dissertation added several new findings to the field. Fixation was found to occur in brainstorming. The induced fixation led to participants decreasing the novelty of their ideas. Temporal analyses provided insight into how various measures (quantity, variety, novelty) fluctuate over the course of a brainstorming session. Lastly, this study

showed that taking a break could lead to increasing the effectiveness of a brainstorming session.

## DEDICATION

This dissertation is dedicated to my friends, Aaron, Elliot, Jon, Mark, and Mike. Whenever I needed help the most, you were always there. You helped push me to meet my goals, yet kept me grounded to what is most important in life: friendship.

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## NOMENCLATURE

AIM	AOL Instant Messenger
EBS	Electronic Brainstorming
RAT	Remote Associate Test
TBR	To-Be-Remembered

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## CHAPTER I

### INTRODUCTION

Ever since brainstorming was introduced (Osborn, 1957), many have latched onto the method as a way in which to merge ideas and resolve problems that organizations face. Unfortunately, as this dissertation will detail, brainstorming is not an efficient means of ideation. When engaging in creative problem solving, individuals often face impediments. One type of impediment that has been examined periodically over the last 100 years (e.g., Maier, 1931; Duncker, 1945; Luchins & Luchins, 1959) is something referred to as *fixation*. While researchers have examined the various causes for lack of efficiency in brainstorming, fixation has not been not one of them. In this dissertation, I will review the literature on brainstorming, the creative process, and fixation on the individual level. From this, I will propose a new theory concerning fixation as an impediment to brainstorming ideation. Three experiments are reported that test this theory. Lastly, this paper will provide a discussion on the implications of the present finding.

#### Introduction to Brainstorming

The concept of brainstorming was first popularized by Alex Osborn (1957). As an advertising manager, he was concerned with increasing the number of ideas for advertising campaigns as well as increasing creativity in organizations. He believed that

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This dissertation follows the style of *Journal of Experimental Psychology: Learning, Memory, and Cognition*.

working in groups is more effective than working individually. However, working in groups is not sufficient for increasing productivity and creativity. In his 1957 book, Osborn provided four rules for brainstorming groups to follow to increase the effectiveness of these groups: (a) Avoid initial judgment and criticism of generated ideas, (b) the wilder the idea, the better, (c) strive to create as many ideas as possible, and (d) look to combine and improve upon suggested ideas. When adhering to these rules, he claimed that group brainstorming could be twice as productive as individual brainstorming (Osborn, 1963). There was some initial supportive evidence for Osborn's proposal. In his 1957 book, Osborn found that engineers produced 44% more "worthwhile ideas" when doing brainstorming in a group rather than individually. Parnes and Meadow (1959) tested if Osborn's rules are effective. Participants who were given the four brainstorming rules generated more ideas than participants not given the rules. However, it is important to note that this study tested participants individually. Still, this finding shows that Osborn's rules are helpful for idea generation. Osborn's concept of brainstorming and rules have had a great impact on organizations and is to this day frequently used in organizations (Tobin, 1998). Additionally, brainstorming is used to develop creative ideas and solutions in areas such as patents, consumer research, marketing strategies, and management methods to just name a few.

#### Advantages of Brainstorming

There are many reasons why group brainstorming should theoretically be advantageous. For one, a group brainstorming session allows for different members of an organization to share ideas (Paulus, 2000). A single person is unlikely to think of

every possible solution to a problem. Also, their experiences will bias them towards a set of generated ideas. However, if they are exposed to other members' views (originating from these members own experiences), then they are more likely to come across ideas that they would have thought in their own brainstorming session. Not only will various members bring their own ideas to the table, but each member will have their unique cognitive architecture and will synthesize ideas differently (Stasson & Bradshaw, 1995).

One of the key benefits of sharing ideas is that bringing together a group of different people should produce a heterogeneous pool of ideas. This typically refers to the belief that groups of individuals with diverse sets of knowledge domains are more likely to benefit from a social exchange of ideas than a group that is more homogenous in domain knowledge. However, group diversity also extends to a heterogeneous group in terms of personality differences. Hoffman (1959) used the Guilford-Zimmerman Temperament Survey to classify participants' personality type. Groups were assembled of either homogenous or heterogeneous personality type. It was found that the heterogeneous groups produced significantly superior and more inventive solutions than the homogenous groups. Thus, it appears that heterogeneity should be sought when creating brainstorming groups.

However, that is not to say that a heterogeneous group is the optimal solution. Stroebe and Diehl (1994) did find that heterogeneity of group membership could increase productivity; however, a heterogeneous group did not outperform a nominal group. Also, heterogeneity does not always lead to creativity. Stasser (1999) found that

when groups share information, they tend to focus on common ideas. So, any benefit from a diverse background of participants might be wasted on the tendency for groups to converge. Furthermore, a review (Paulus, 2000) of group member diversity finds that diversity does not always lead to greater creativity and can some times hinder innovation. In conclusion, when brainstorming is done at the group level, the data is mixed whether or not it is advantageous to have members of a diverse background. Likely there are some mitigating factors (e.g., free communication) that determine whether the benefits of multiple knowledge domains will be helpful towards group ideation.

Another reason that brainstorming should work is with group satisfaction. Research shows that there is a positive relationship between job satisfaction and job performance (Judge, Thoresen, Bono, & Patton, 2001). If people are highly satisfied with the idea of pooling their efforts together in a brainstorming session, then they should be more likely to be more productive. Sure enough, people participating in brainstorming groups reflect positively on their experiences in the group (Camacho & Paulus, 1995; Cohen & Bailey, 1997; Diehl & Stroebe, 1991). Two likely explanations exist for why people prefer to work in groups rather than individually (Nijstad, Diehl, & Stroebe, 2003). Possibly it is due to social comparison. You experience satisfaction in knowing that your own performance is on par with other members. It is also possible that people are gaining satisfaction through source confusion. During the course of the session, several quality ideas are generated. Afterwards, individuals might incorrectly recall another member's idea as belonging to their own. It is important to note that the

cited literature shows that people's favorable reports are coming from after the brainstorming session. It is not known whether they were pleased with the process while they were actually brainstorming with their group members. However, one can assume with previous group brainstorming experiences, members will feel pleased during subsequent group sessions. Therefore, in theory, they should have a positive affect, resulting in higher productivity.

### Brainstorming's Shortcomings

#### *Productivity Deficit*

Despite the theoretical reasons why brainstorming should be effective, there is overwhelming evidence that group brainstorming is less productive than individual brainstorming (Diehl & Stroebe, 1987, 1991; Mullen, Johnson, & Salas, 1991; Taylor, Berry, & Block, 1958). To individuals not familiar with the literature, these findings may come as a bit of a surprise. After all, countless organizations engage in group brainstorming. Also, as previously mentioned, group members feel pleased with the process.

It is worth clarifying what it is meant by group brainstorming being outperformed by individual brainstorming. Typical brainstorming experiments compare performance by a group of participants ("real groups") to that of the summed effort of the same number of participants working individually ("nominal groups"). For example, the efforts generated by a real group of 5 participants might be compared with the total effort produced by 5 other participants who worked on their own. The "productivity deficit" between real and nominal groups has always been defined in experiments in

terms of the number of ideas generated by these two types of groups. For example, in the Taylor et al. (1958) study, participants were given three creative problem situations to generate ideas on. Participants were randomly selected into groups of 4 or assigned to work individually. When summing the ideas from 4 individuals (nominal group), this number (73) was found to exceed the number of ideas produced the real group (41). Furthermore, a meta-analysis (Mullen et al., 1991) of the brainstorming literature showed that not only do real groups yield quantitatively fewer ideas ( $Z = .79$ ), their quality of ideas is significantly less than nominal groups ( $Z = .88$ ).

### *Social Causes*

There are numerous reasons for why group brainstorming is less productive than individual ideation (Mullen et al., 1991; Stroebe & Diehl, 1991). It is possible that various social factors cause each group member to not give as much effort as they would in an individual setting. Possibly group members are not attending to ideas proposed by their peers. We also need to question if the deficit is due to cognitive mechanisms that arise in group settings. The problem may also just be simply a matter that not everyone can speak at once. The next section will review the proposed reasons for why group brainstorming is less effective than individual brainstorming.

When placed in an interactive group setting, each member will be able to monitor the efforts and productivity of their fellow group members. As a result, social comparison is thought to occur in brainstorming groups (Paulus & Brown, 2003). A number of possible outcomes can arise from social comparison: social loafing, free-riding, downward comparison, and upward comparison. Social loafing refers to when



individuals give less effort in a group setting because the responsibility of the task is diffused (Latane, Williams, & Harkins, 1979). Free-riding is essentially the same thing as social loafing. If a group member feels that the other members are fulfilling the group task and that his or her contribution will not be apparent, then this member will provide a minimal contribution (“free-ride”). For example, one study found that when participants were placed into groups (each member had their own microphone) and asked to yell as loud as they could as a group, participants loafed and did not exert their maximum effort (Williams, Harkins, & Latane, 1981). However, when participants were told that experimenters could monitor individual voice levels, no loafing occurred and participants yelled with much higher intensity. Thus, loafing decreases when identifiability is present. However, it is not the case that lack of identifiability is the sole cause for social loafing. Harkins and Petty (1982) further examined social loafing in situations where participants were given an easy or a difficult brainstorming task and were told that they were working individually or that their efforts were pooled with nine other members. When participants were given the easy task, social loafing occurred (performance was lower in pooled-efforts condition). However, if the task was difficult, there was no performance difference between participants who were identifiable and participants who thought their efforts were part of a group effort. In a subsequent experiment, participants were told that they would be brainstorming novel uses for an object. They were either told that each member would be generating uses for the *same* object or generating uses for a *different* object. Participants were led to believe that their ideas would be pooled and not be identifiable. It was found that when participants had

their own task, social loafing did not occur. Thus, from the Harkins and Petty study, we can conclude that lack of identifiability is not sufficient for social loafing. If the task is a personal challenge or is one in which they can make their own important contribution (even when not identifiable), people will be motivated enough to resist social loafing. So, it is not the case that brainstorming groups will always suffer from social loafing.

Very similar to social loafing is social matching. People have shown a tendency to conform to their peers (Asch, 1951). From judgments to brainstorming, people's choices and performance will be heavily influenced by their peers. According to Latané's social impact theory, "increases in the strength, immediacy, and the number of people who are the source of influence should lead to increases in the effect on an individual" (Latané, 1981, p. 345). This might explain why nominal groups outperform real brainstorming groups when the sizes of the groups are over the size of two people. With larger groups comes greater conformity and possibly greater downward performance matching. Paulus and Dzindolet (1993) tested to see if there exists a matching process in brainstorming groups. To do this, they compared the correlations of performance in brainstorming partners in real groups versus that of nominal groups. They found that real group partners' performance was more highly correlated than the nominal partners' performance. Also, the social influence process developed very early and was maintained throughout the session. In another experiment, participants were placed into real groups or worked individually to complete a brainstorming task. Prior to the session, half of these individuals/groups were given information that a typical person/group generates 65/100 ideas (this is actually much higher than in reality).

Paulus and Dzindolet found that providing participants with this standard had the effect of elevating the number of ideas produced by the individuals and groups. From these experiments we find support for the notion that matching does exist in brainstorming groups. It can come from interactions with group members or from learning information about other groups' performances. Furthermore, Paulus and Dzindolet provide evidence that it is possible that brainstorming groups are capable of upward social matching, not just downward social matching.

Social comparison can lead to social loafing. However, being aware of people around you can have another detrimental effect on performance. Brainstorming group members who are worried that their contributions are being evaluated might feel apprehensive about volunteering ideas, especially ones that are wild. Thus, these members will lower their productivity as well as violate two of Osborn's brainstorming rules. In order to test whether evaluation apprehension occurs in brainstorming groups, Collaros and Anderson (1969) manipulated the extent to which group members felt that their peers were experts. In one group, each of the four group members were given a sheet that stated that the other *three* members all were brainstorming experts. In the other experimental group, each of the four group members were given a sheet that stated that *one* of the other members is a brainstorming expert. Participants in the control group received no information about their fellow group members. The control group produced the highest number of ideas; the all-experts group produced the lowest. In a post-experiment survey, participants in the all-experts group reported the greatest amount of inhibiting their ideas and sensed the greatest amount of disapproval from

fellow members. From the Collaros and Anderson experiment, there is evidence that the more a person feels they are surrounded by experts, the more they feel threatened, and in turn censure their ideas.

Camacho and Paulus (1995) further expanded upon this by examining if there are individual differences that would lead to evaluation apprehension. By using the Interaction Anxiousness Scale, they were able to divide their study participants into ones of low-anxiety and high-anxiety. Type of group (real vs. nominal) was crossed with interaction anxiety level (low vs. high). Camacho and Paulus found that in the case of real brainstorming groups, low interaction anxiety levels significantly increased the number of ideas generated. Furthermore, high-anxiety participants expressed hesitancy about expressing ideas during the brainstorming task. From these two studies (Camacho & Paulus, 1995; Collaros & Anderson, 1969), it does appear that evaluation apprehension can contribute to the productivity deficit found in group brainstorming. In order to avoid such productivity loss, it is best to select groups composed of members that are low in interaction anxiety and also have similar amounts of brainstorming experience.

### *Production Blocking*

So far the reviewed possible causes of the productivity deficit in brainstorming groups have centered on social interactions. Diehl and Stroebe (1987) tested these possible causes of productivity loss as well as another cause – production blocking. In the first experiment, they tested free-riding by telling group members whether their individual responses would be compared to another individual or if their pooled

responses would be compared to another group. They found that the personal comparison instructions yielded more ideas than the collective instructions. Although this provides support for the social loafing theory, Diehl and Stroebe dismissed it because the instructions only accounted for a small percentage of the differences observed. Their second experiment sought to test if evaluation apprehension was responsible for productivity loss in real groups. Participants brainstormed individually on controversial or uncontroversial topics. Half of these participants were told that a judge would evaluate their responses. It was found that the presence of these judges led to evaluation apprehension; fewer ideas were produced in controversial and uncontroversial conditions. However, in a subsequent experiment, Diehl and Stroebe found that evaluation apprehension was only found in situations in which participants were instructed that their performance would be compared with other individuals. In cases where groups were told that their responses would be pooled together, the presence of judges did not lower output. Diehl and Stroebe took this result to believe that evaluation apprehension is not responsible for productivity loss. In their last experiment, they assessed production blocking, which refers to the theory that brainstorming groups are inhibited by the simple fact that multiple group members cannot speak at once. To test this, some groups simulated the production blocking by having members placed in separate rooms and were only allowed to speak into a voice recorder when other members were not talking (blocking group). These groups were compared with a group that had members in different rooms, but were allowed to voice their ideas whenever they liked (non-blocking group). Additionally, data was collected from a real group with

members in the same room (control group) and a nominal group (4 individuals with ideas pooled together). For this experiment, the nominal group and the non-blocking group produced significantly greater ideas than the blocking groups and the control real group. There was no difference between the nominal group and the non-blocking group. Diehl and Stroebe took this as strong supportive evidence for production blocking being a significant cause of productivity deficit in brainstorming groups.

Diehl and Stroebe followed up their seminal study with another to further examine the source of production blocking (1991). Their first experiment examined whether or not it is the case that brainstorming groups simply do not have enough time as nominal groups because real groups are sharing a vocal platform. It was found that more ideas were produced in a real group (4 members) given 20 minutes to brainstorm than a nominal group composed of 4 members, each given 5 minutes to work. So, amount of time may be a factor; however, amount of time to verbalize ideas may be confounded with amount of time to think. A subsequent experiment found that it is not simply the amount of speaking time that is the major factor. Rather, it is more likely that members in real groups have to wait on other members to stop talking. Members who are waiting on others are not using this waiting time effectively. In their third experiment, they examined if productivity could be increased by making the times in which it was members turn to speak more predictable. Interestingly, increasing the predictability of the speaking times did not increase productivity, and actually decreased it. It was possible that this was due to the limitations of short-term memory; members are unable to listen to others' ideas, rehearse in short-term memory ideas they have

thought of, and think of new ideas. Diehl and Stroebe's last experiment sought to test this by giving some of their participants a note pad to use when it was not their turn to speak. In groups where blocking was induced (members had to wait their turn to speak), the use of a note pad increased the number of ideas generated. Taken together, these two set of experiments (Diehl & Stroebe, 1987, 1991) lend support for the notion that production blocking is a significant contributor of the brainstorming productivity deficit. Specifically, due to the fact that only one member can contribute ideas at a time as well as the limitations of short-term memory, brainstorming group members are unable to utilize their time efficiently.

#### *Cognitive Causes*

There are other possible causes for deficits observed in group brainstorming. Rather than due to social causes, the deficit may be due to cognitive mechanisms. As previously mentioned, it is possible that the tasks required in group brainstorming (monitor discussion, rehearsing ideas until your turn to speak, generating new ideas) may be too demanding for one's short-term memory. This is supported by the finding that longer delays between generation of ideas and articulation of ideas led to a productivity decline (Nijstad, Stroebe, & Lodewijkx, 2003). Furthermore, it has been theorized that contributions from other group members not only stimulate a member, but can also interfere with their mental processes (Hinsz, Tindale, & Vollrath, 1997).

Another cognitive mechanism at play is that group members are simply not allocating enough attention to the contributions of other members. Paulus and Yang (2000) tested this by giving participants two brainstorming sessions, separated by a

memory test. In the nominal condition, participants generated ideas individually in both sessions. In the group condition, during the first session, participants wrote ideas on slips of paper and shared them with one another. However, in the second session, they generated ideas individually. In a third condition, participants followed the same procedure as the group condition, except that they were informed of the memory test to come. It was found that the group condition yielded more ideas than the other two conditions. Paulus and Yang reasoned that this was due to paper slip method allowing members to attend to the one or two ideas listed on the slip (compared with a real brainstorming group session where they are inundated with ideas). However, in addition to their attention hypothesis, one could also interpret their findings as support for the theory that normal group brainstorming can lead to a cognitive overload (Hinsz et al., 1997; Nagasundaram & Dennis, 1993; Nijstad, Stroebe, & Lodewijkx, 2003). There is another possible cognitive mechanism that may be a factor in group brainstorming – fixation. This topic will be discussed later in this paper.

On the surface, the productivity deficit in brainstorming is quite similar to collaborative inhibition. Collaborative inhibition refers to the phenomenon in which a group of individuals working together to recall information is less effective than individuals working alone (Weldon & Bellinger, 1997). While single group will recall more than a single individual, the group will recall less than that of a nominal group. Weldon and Bellinger believed that collaborative inhibition, like the brainstorming deficit, was due to a multitude of factors such as social loafing, evaluation apprehension, and production blocking.



Evidence also points to the part-list cuing effect as responsible for collaborative inhibition. Inhibition was found to be greater for recall of lists made up of few categories containing numerous items than for recall of lists composed of numerous categories containing few items (Basden, Basden, Bryner, & Thomas, 1997). Additionally, Basden et al. found categorical clustering to occur less frequently in collaborative recall than in individual recall. It has also been found that collaborative inhibition occurs in groups as small as two individuals (Finlay, Hitch, & Meudell, 2000). It was found that collaborative pairs recalled fewer correct items than did nominal pairs. Finlay et al. concluded that each partner's recollections acted as part-set cues for the other person.

In regards to brainstorming groups, it is possible that when a group member offers an idea, a part-list cuing effect occurs. This suggested idea strengthens the activation of the idea in other group members relative to alternate ideas that they could form as a solution to the brainstorming problem. Thus, like collaborative inhibition, one member's retrieval strategy could interfere with others' retrieval strategies.

It is worth noting that the vast majority of the reviewed studies on brainstorming have focused on brainstorming tasks involving participants generating as many ideas as possible on a topic. Participants' ideas are typically short responses as the goal of the experimental task is to generate as many ideas as possible in the allotted time. In real-world situations, organizations sometimes focus on developing a single good solution rather than many possible ideas for a solution. So, we must give pause before applying the reviewed findings to external situations. That being said, the purpose of these

reviewed studies is to determine the reasons for the productivity deficits in situations that pertain to groups following Osborn's (1957) rules (e.g., generate as many ideas as possible).

#### Attempts to Eliminate Brainstorming Deficits

##### *Electronic Brainstorming*

There are a couple ways in which researchers have attempted to improve group brainstorming in order to overcome its productivity deficits. One such technique is electronic brainstorming (EBS). EBS began being used in the early 1980s as a new form of communication for groups (Dennis & Williams, 2003). In a typical EBS system, each member is seated in front of a computer console. These consoles are connected via a server that relays ideas from a participant to the other group members (see Appendix A). Depending upon the EBS system, one or multiple ideas from other users can be displayed on a member's computer monitor. Thus, a user's computer monitor might have an idea(s) proposed by other members listed at the top of the screen, with room at the bottom of the screen for the user to submit his or her own contribution. Whereas normal brainstorming groups are typically limited in size by the size of the room/table where the group meets, EBS allows (theoretically) an infinite number of group members. Additionally, EBS does not limit group members to all be in the same location. Much like instant messaging programs (AIM, Yahoo Messenger, ICQ), members can communicate from places around the globe.

As reviewed, real brainstorming groups suffer from the possibility of evaluation apprehension, production blocking, and basic cognitive limitations. EBS offers a means

to overcome all three of these drawbacks. With an electronic medium, it is possible to maintain anonymity. Thus, users of EBS should exhibit lower amount of evaluation apprehension and be more willing to propose wild ideas. Because each user is at a computer console, there is no issue of only one group member speaking at a time. Multiple members of an EBS group can submit their ideas concurrently. Due to the computer interface, a user can decide when they want to focus on generating their own ideas and when they want to attend to other members' contributions. This flexibility, in theory, should dramatically lighten their cognitive load.

All of this being said, empirical evidence needs to be evaluated in order to assess whether or not EBS overcomes the drawbacks of normal group brainstorming. Gallupe, Bastianutti, and Cooper (1991) tested if EBS eliminates production blocking. Four groups were given 15 minutes to generate ideas on a brainstorming situation: electronic-nominal, electric-interacting, nonelectronic-nominal, nonelectronic-interacting. They found a main effect of medium; more ideas were generated when using an electronic interface. However, there was no interaction. Electronic brainstorming did not benefit the interacting groups more than the nominal groups. Valacich, Dennis, and Connolly (1994) further examined the potential productivity gains by using EBS. In a series of experiments, they compared the number of ideas produced by nominal groups with that of EBS groups of various sizes. For EBS groups, the number of ideas increased with group size. For groups with a small number of members, nominal groups generated more ideas. However, when the group membership was nine people or greater, then the EBS groups produced more ideas than the nominal groups. In their last experiment,

Valacich et al sought to determine why EBS was beneficial. The productivity of a nine-member EBS group was compared with another nine-member EBS group that had induced blocking. This later group's EBS system only permitted one member to type at a time. As predicted, the normal EBS group generated significantly more ideas than the modified EBS group. The authors took this as evidence to conclude that the effectiveness of EBS appears due to production blocking. It is worth noting that this study did not test the other possible benefits of EBS (e.g., piggybacking, elimination of evaluation apprehension, etc.), therefore, it is possible that Valacich et al. were premature in their conclusions. A later study sought to test if EBS is effective in reducing evaluation apprehension (Cooper, Gallupe, Pollard, & Cadsby, 1998). Participants either brainstormed on controversial or non-controversial topics. They were either placed in EBS groups offering complete anonymity, EBS groups that tagged each idea's originator, real brainstorming groups, or they brainstormed individually with anonymity (nominal group). Anonymity did make a difference; the anonymous groups (EBS or real) produced more ideas than the non-anonymous groups. However, contrary to predictions, brainstorming on controversial topics did not amplify the effect. Lastly, it was found that the anonymous EBS group was the only group to produce as many ideas as the nominal comparison. From Cooper et al.'s study, it appears that EBS does offer some recovery from brainstorming productivity deficits resulting from evaluation apprehension.

In sum, EBS appears to offer a method in which to partially remove the detrimental effects of production blocking as well as evaluation apprehension. Although

not tested, it is possible that EBS also offers a medium in which to unburden the cognitive demands of a real group brainstorming session (Gallupe et al., 1991; Nagasundaram & Dennis, 1993). What does seem to be apparent across a number of studies is that group size is the critical factor in determining EBS effectiveness (Dennis & Williams, 2003). EBS groups perform below real and nominal groups with small group sizes, but yield a greater number of ideas in larger groups. This is likely due to EBS reaping the benefits of more members, without the costs found in real group brainstorming (e.g., production blocking). While EBS may be appealing, there are a few things worth mentioning. First, by creating an anonymous work environment, the use of an EBS system invites members to engage in social loafing. So, it is possible that whatever benefits arise from the elimination of evaluation apprehension are counteracted by the loss of motivation from individuals. Second, it is possible that the experimentally-observed production gains when using EBS may be an artifact of its novelty (Cooper et al., 1998). Therefore an organization that uses EBS on a regular basis might find that its members will not perform as well over time as the novelty wears off. Lastly, EBS may not be an option for many organizations that lack the resources for such a system or have a culture that puts much emphasis on face-to-face contact.

#### *Increasing Attention*

Another way in which researchers have tried to improve group brainstorming is by trying to improve individual motivation levels and get them to focus on the task at hand. The reasoning behind this is that group members may not be sufficiently motivated to listen to the contributions of their fellow group members (Dugosh, Paulus,

Roland, & Yang, 2000). Dugosh et al. attempted to increase participants' attention to others' ideas by telling them that their memory for those ideas will be tested later on. In the first experiment, participants listened to ideas being played on a tape recorder and half of the participants were told to try and memorize the ideas for a later memory test. Following the memory test, participants engaged in individual brainstorming on the same topic as the one on the audiotape. Participants who were warned of an impending memory test did recall more ideas than participants who were not foretold of the memory test. Furthermore, participants who were given the memory instructions generated more ideas than the participants not given the instructions. In the second experiment, experimental groups and the control group were given two brainstorming sessions. For the experimental groups, in the first session they listened to an audiotape (containing a low or high number of ideas) and concurrently generated their own ideas. In the second session, they had no cues (like the control). It was found that participants hearing a high number of ideas generated a higher number of unique ideas (not from the audiotape) than participants hearing a low number of ideas. Also, the experimental groups outperformed the control group in the second brainstorming session. This suggests that the benefits of hearing others' ideas in group brainstorming may not be evident until later individual brainstorming sessions, something that was advocated by Osborn (1963). Dugosh et al.'s last experiment tested their attention predictions with EBS. Three conditions were tested: normal EBS; EBS with instructions to memorize others' ideas; and a nominal group. For all three groups, the second session consisted of individual brainstorming. It was found that for both brainstorming sessions the EBS-

memory group generated more ideas than the other two groups. Thus, real brainstorming groups and EBS groups both benefit from members attending more to others' ideas.

### *Modifying Instructions*

Similar findings came from testing whether additional instructions can improve group performance (Paulus, Nakui, Putman, & Brown, 2006). In some conditions, a facilitator was present in the room. Another manipulation was that some participants only received Osborn's original four rules, whereas others received additional brainstorming rules (e.g., stay focused on the task). The presence of the facilitator did not affect performance, but providing additional rules did enhance performance. These two studies (Dugosh et al., 2000; Paulus et al., 2006) show that some of the deficits observed in group brainstorming originate from members not being motivated to pay attention to their peers and staying on task. However, through additional instructions to stay on task or to pay careful attention to others' ideas, this productivity loss can be minimized.

### Use of Stimuli and Analogies When Problem Solving

When attempting to understand creativity, especially creative problem solving, it is pertinent to evaluate the impact of stimuli on the creative process. The production of something novel requires stored knowledge. This knowledge can come in the form of facts, events, concepts, recently presented stimuli, and relevant analogies. People are not always aware that they are using information when engaging in creative tasks.

### *Unconscious Plagiarism*

For example, it has been proposed that creative individuals have a broader attention span and are thus exposed to information from a wider variety of sources (Mendelsohn & Griswold, 1964). One by-product of a wider attention span is that not only will you be more likely to pick up relevant information to the problem at hand, you are more likely to unknowingly obtain ideas from other people. Marsh, Landau, and Hicks (1997) examined the role of limited attention resources in unconscious plagiarism. They were able to test this through a paradigm in which participants engage in group brainstorming and then later generate ideas individually. The premise was that source monitoring requires controlled processing. They predicted that when source monitoring was not the primary task, unconscious plagiarism would occur. In the first experiment they found that there was more inadvertent plagiarism following a delay between group and individual ideation as opposed to immediate individual ideation following the group session. In Experiment 2, they found that participants were able to reduce the amount of cryptomnesia when asked to focus on the source of their ideas. In Experiment 3, the experimenters manipulated the amount of time allotted for the individual ideation. All participants brainstormed in groups and later generated ideas individually. Participants in the limited-time condition plagiarized group members more than participants who were given unlimited amount of time for individual ideation. In the last experiment, they further examined the impact of verbal instructions to avoid source errors. Participants given the “lenient” instructions were asked to avoid plagiarism, whereas participants given the “strict” instructions were asked to avoid plagiarism and work hard



to avoid it. During the actual individual ideation session, participants were placed either in a room by themselves or in a room with other participants engaged in individual ideation. The experimenters found that in the isolation setting, the stringent instructions only slightly reduced plagiarism. However, in the group setting, the stringent instructions greatly reduced plagiarism compared to the lenient instructions. From these four experiments, Marsh et al., were able to conclude that often people fail to apply stringent decision criteria when making source decisions. Source errors typically occur because when the problem context is reinstated, previously encountered ideas/solutions are reinstated without the awareness that these ideas are not novel. If told to use a stringent decision criterion, people are able to reduce the amount of these source errors. What these findings relate to the creativity field is that while a broad attention span can be helpful in obtaining information relevant to the problem at hand, people need to devote some resources to being aware of the source of the information. Otherwise they will unknowingly be recycling someone else's old idea or worse, latching onto and wasting efforts pursuing a "dead-end" idea.

#### *Diversity of Information*

While it appears that information presented can influence creative problem solving, it is important to examine the influence of the *type* of information presented. Along the lines of the divergent thought camp, it is possible that presenting a person with a wide range of information might prompt that person's own divergent ideas. Diverse stimuli presented concurrently are not as easily "chunked" in short-term memory as stimuli low in diversity. Therefore, it can be argued (Nagasundaram &

Dennis, 1993) that diverse stimuli will require more cognitive processing and thus each stimulus can evoke more ideas. Additionally, diverse stimuli come from a broader spectrum of domains and might lead a person to explore more domains in their own ideas. However, this can come at a cost. While heterogeneous sources of information may produce more stimulation, this could be too much information for a person to process and harm ideation. Sometimes it is better to receive information from homogenous sources. Nagasundaram and Dennis (1993) predicted that chunks of information that are homogenous in nature are likely to be better at generating ideas that explore a concept in depth. So, when engaged in ideation, information provided can have a multitude of effects. If diverse, it can evoke more thought and possibly lead to divergent ideas. If the information is not diverse, it is less likely to lead to an information overload and can be helpful in exploring a concept in depth. What type of information that should be sought depends upon whether the individual intends to explore a concept in depth or in breadth.

These findings are supported by examining the effects of stimulus diversity on individual brainstorming (Nijstad et al., 2002). Participants were exposed to semantically homogenous or semantically heterogeneous stimuli (from a norming study, ideas were collected that were divided into either domain homogenous or domain heterogeneous). This factor was crossed with whether the stimulus was clustered semantically or it was presented in a random sequence. Nijstad et al. found that participants who were exposed to heterogeneous stimuli generated more categories of ideas. Furthermore, exposure to a random sequence of stimuli led to a lower semantic

clustering of participants' own ideas. Participants who were exposed to homogenous stimuli did produce a larger number of ideas per category. While it appears that heterogeneous stimuli can lead to a person generating more divergent ideas, we must be careful to not equate this finding with the statement that "novel stimuli evokes novel ideas." Connolly, Routhieaux, and Schneider (1993) looked at this very statement. Participants engaged in individual ideation at a computer terminal in which they were asked to come up with ideas to solve a budget-balancing problem. They received either a common example solution or a unique example solution (examples were produced by other participants in an earlier norming experiment). Those who received the common example produced more original ideas than participants receiving the unique example. Thus, if we were to define creative ideas as being divergent and original, then it would appear that creative ideas are best generated by stimuli that are unique, but common in nature. It is worth noting that no known study has examined the effect of unique examples on whether or not the participants' ideas will be divergent or convergent in nature.

#### *Analogical Transfer*

So far much of the discussion regarding stimuli and ideation has focused on the experimenter-provided stimuli. It is also the case that stored conceptual knowledge can influence one's creative process. One example of this is analogical transfer. This refers to the case in which a novel problem is solved by applying principles used to solve an earlier problem. A famous example of this is the Radiation Problem (Duncker, 1945). In this problem, participants are told that there is a malignant tumor deep inside a

patient's body. The doctors have at their disposal a special radiation ray that is harmless at low intensity. When used at a high intensity, it can destroy the tumor, but will also destroy surrounding healthy tissue. What can be done to avoid the latter? Participants are typically not successful in solving this problem. However, they are more successful if they are then told the General story. In this story a general wishes to capture his enemy's fortress and prepares a large number of men for the attack. A direct assault is futile because the fortress is surrounded by mines that will blow up if there is a large concentration of men marching together. The general solves the problem by dividing his army into many small groups of soldiers that attack from several points at the same time. After reading the General story, participants are able to apply the analogy (small concentration from numerous points at once) to solve the Radiation problem. Gick and Holyoak (1980, 1983) used this same Radiation problem to further study analogical transfer. Only 10% of participants could solve the Radiation problem initially. After hearing the General story, this rate increased to 30%. However, if the experimenters prompted the participants to relate the two stories, the rate jumped to 75%. Furthermore, the transfer rate by providing two conceptually similar examples instead of just one. These experiments show that people can apply concepts learned from one situation to a novel situation. However, people do not always immediately apply the analogy. They typically need to be made aware of the similarity between the two situations. So, it appears that analogical transfer can be useful for ideation, but it is a conscious effortful process.

Another question that arises with the topic of analogy transfer is the order of presentation of the stimuli. The majority of analogy transfer studies have first presented the analogy (source) to participants and then presented them with the problem-at-hand (target). Christensen and Schunn (2005) looked at the reverse case in which the target is presented first and then the source. Their methodology was akin to an incubation experiment in which a problem is presented; an incubation period follows with the possible appearance of hints, followed by a second attempt at solution of the problem. Participants were given eight insight problems. Every 5 minutes they were given a cue (problem + solution) to look over. Half of these cues were analogous to the insight problems and the other half were unrelated. Christensen and Schunn found that analogous-cued insight problems were solved at a significantly higher rate (.53) than the unrelated-cued insight problems (.17). Following the presentation of an analogous cue, participants typically immediately returned to the relevant insight problem. Post-experiment questionnaires revealed that participants were aware of the connection between the cues and the insight problems. These findings provide support for the idea that people are able to spontaneously map analogies and that this process is done consciously. It also lends support to the Opportunistic Assimilation Theory (Seifert, Meyer, Davidson, Patalano, & Yaniv, 1995) that relevant information in the environment can trigger spontaneous access to similar, unresolved problems (to be discussed in more detail in the following section).

If spontaneous analogical transfer is possible, how can we encourage people to use it in creative problem solving? One possibility is to modify the way in which the

source material is presented. Needham and Begg (1991) examined transfer appropriate processing in transfer. Participants received source problems as well as an explanation of the solution by the experimenter. They were then told to either study each story so that they could recall it later (memory-oriented) or to explain why each solution was correct (problem-oriented). Then participants were given insight problems to solve (target). It was found that participants who focused on the solution to the source were better at solving the target problems. This was also found to be true whether the source was presented in the form of stories or problems. However, the advantage of problem-orientation disappeared when the experimenter did not explain the solution of the source problems. This is in parallel to the Gick and Holyoak (1980, 1983) findings that people need to be cued into the similarity between the source and the target. While the participants in the Needham and Begg study were not given a hint as in the Gick and Holyoak experiments, it is clear that additional processing of the source problems are needed in order to successfully transfer the analogy.

Another way in which spontaneous analogical transfer might be facilitated is through context. Context-dependent effects have been demonstrated on memory retrieval (Smith & Vela, 2001). Specifically, retrieval of items improves when the physical or mental context of the encoding phase is reinstated. Spencer and Weisberg (1986) looked at the effect of context on analogical transfer. In the first experiment they manipulated the number of analogous source problems as well as whether or not participants were given instructions that the source problems are helpful for solving the target problem. Spencer and Weisberg found that transfer only occurred in hint-aided

groups and that the hint-aided groups benefited from more analogies. The second experiment manipulated the presence of a delay between presentation of the source and target problems. Context was also manipulated by having a different experimenter proctor the target problem in a different context (classroom demonstration). No transfer was observed for the condition in which the problems were presented in different contexts with a delay. Although not significant, there was a trend of greater transfer in the condition where the problems were presented in the same context with no delay. These findings appear to provide evidence that similar encoding context is necessary for unprompted analogical transfer. However, we must give pause before certifying the authors' conclusion. It would be beneficial to examine analogical transfer using a similar paradigm used in context-dependent memory experiments.

So, in sum, it appears that the role in which presented information is applied in the ideation process is complex. There are competing factors regarding the type of stimuli presented to people. Information should be relevant to the problem at hand, so as to prevent the wasting of efforts. However, information should not be too narrow. Divergent information can lead to more creative products. If attempting to explore a single concept in depth, presenting homogeneous information to a person is ideal. However, if the goal is to explore many areas, heterogeneous information is more applicable. If the goal is to evoke unique products from an individual, then it is best to provide them with ideas that are common and homogeneous in nature. Lastly, in order to facilitate analogical transfer, it is best to provide that person with multiple similar

problems and to improve the situation (through hints, same context, or more detailed source encoding).

### Fixation in Individual Problem Solving

An impediment to creative problem solving is *fixation*. Fixation can be defined as “something that blocks or impedes the successful completion of various types of cognitive operations, such as those involved in remembering, solving problems, and generating creative ideas” (Smith, 2003, p. 16). Fixation can occur due to typical thinking, implicit but incorrect premise, recent experience, having to use an object in a novel way, and an unwillingness to detour from a direct path towards a solution (Scheerer, 1963; Smith, 2003).

#### *Functional Fixation*

One of the earliest documented types of fixation is functional fixedness, that is, being unable to think of non-ordinary ways in which known objects can function. Duncker described functional fixedness as a mental block against using an object in a new way that is required to solve a problem (1945). He demonstrated this with his famous candle problem. Participants were given a candle, a box of matches, and thumbtacks. The goal was to create a wall-mounted candleholder. In order to solve this insight problem, participants had to overcome their functional fixedness regarding the box as simply a container for the matches. If they tacked the box to the wall, they could then place the candle on top of the box.

Another example of functional fixedness is with Maier’s two-string problem (1931). He looked at whether or not people could utilize incidental stimuli to overcome



functional fixation. Participants were taken to a large room with poles, ringstands, clamps, pliers, extension cords, tables, and chairs. Also in the room were two strings hanging from the ceiling that were placed a significant distance apart. The task was to tie two strings together. There were four ways in which to solve this task and participants were asked to come up with all the solutions. Maier was most interested to see if participants could come up with the most non-obvious solution – using the pliers attached to one of the strings to create a pendulum. If participants were unable to think of this solution, the experimenter would casually brush up against one of the strings to set it in motion. If this was not enough to spark the solution, the experimenter handed the participant the pliers and told them that the task could be solved using only this object. Of the participants who did not immediately solve the task, 62% solved it following the hints. These participants did not report noticing the experimenter brush against the cord, but still appeared to utilize the hint. Maier's study showed that the majority of people struggled with functional fixation, but were able to overcome it when they transformed the way they viewed objects – the string as a pendulum and the pliers as a weight.

Adamson and Taylor (1954) explored ways in which to resolve functional fixation. They first induced fixation in their participants by having them complete an electric circuit with either a microswitch or a small relay. Later, participants completed the two-string problem. The amount of time between the electric circuit task and the two-string problem was manipulated between subject groups. Participants who used the microswitch to complete the electric circuit were less likely to use the microswitch as the

pendulum weight. Similarly, participants who completed the circuit with the relay were less likely to use the circuit as the pendulum. Thus, Adamson and Taylor found that temporary functional fixation can be induced via experience. That is, using a switch or a relay in its typical functional mode made it more difficult for participants to think of using the same objects for other functions, such as a pendulum weight. Functional fixation decreased with longer intervals. Thus, it appears that functional fixation can be resolved with greater retroactive interference arising from longer intervening activity.

Obviously experience with objects will influence the degree of functional fixedness. If a person has no experience with an object and has not seen others use the object, then we would not expect that person to exhibit a high amount of functional fixation. Furthermore, if the experience with the object is limited, the functional fixedness with this object can be depressed with a long intervening period between uses of the object.

#### *Impediments to Memory Retrieval*

Fixation can also occur in memory retrieval. If you are attempting to retrieve an episodic memory or recall a list of words, you can become fixated on the wrong event or a word already recalled. This is typically referred to as a “memory block.” The only necessary mechanism for a memory block is response competition (Smith, 2003). For example, if a person with limited geographical knowledge of Australia was asked what was the capital of Australia, “Canberra” might face response competition from “Sydney” and “Melbourne” because of their strong association with “Australia.” Furthermore, if “Sydney” or “Melbourne” is retrieved initially, this could lead to a biased retrieval set.

Retrieval of these associates increases the likelihood of retrieving them again and will consequently decrease the likelihood of retrieving the temporarily inaccessible memory of “Canberra.” As mentioned, memory blocks are not limited to the retrieval of just one item. It can also occur when attempting to retrieve a list of items. Smith and Vela (1991) investigated whether these memory blocks can be removed. In the basic paradigm, participants were given a list of items to remember, followed by two free-recall tests. The second test either immediately followed the first test or was separated by an incubation interval. The length of the free-recall tests, the duration of the incubation interval, and the nature of the incubation activity (filled or unfilled) was manipulated across a series of experiments. Smith and Vela found that reminiscence, an increase in items recalled from the first free-recall test to the second, was greater following longer incubation intervals and when these intervals were filled with problem-solving. Combined, these results indicate that memory blocks can be resolved via incubation. A probable explanation was that fixation occurred during the first retrieval attempt because only a few elements from memory are able to be sampled (Bower, 1972). After an incubation interval, a different set of items from memory can be sampled, leading to reminiscence.

#### *Effects of Recent Experience*

Fixation can also arise from recent experience. Luchins and Luchins (1959) demonstrated a certain type of fixation, mental set, in their water jar problems. Participants completed numerous problems in which they were given three jars of varying sizes and were asked to obtain a required amount of water. In each of these

problems, the solution was obtained by following the same strategy. Next, participants were given “critical” test problems. Participants tried to apply the same strategy, even when it was inappropriate. Thus, like induced functional fixation (Adamson & Taylor, 1954), a mental set can be created from mere experience with previous problem solving.

#### *Fixation Due to Domain Knowledge*

With experience in performing tasks comes expertise. Obviously expertise is a valued trait in most professions because of the knowledge and experience associated with it. However, is it possible that expertise can be detrimental in certain situations? Wiley (1998) looked at the case where expertise can become a mental set. Baseball-knowledge experts were compared with baseball-knowledge novices on solving RAT problems. In the “baseball consistent” problems, the solution could be used to form a baseball phrase (e.g., “plate broken rest” – HOME). This is in contrast to the “baseball misleading” problems in which fixation could occur as a result of thinking of baseball phrases (e.g., “plate broken shot” – GLASS). Participants who were classified as experts were more likely to show a decrement on the misleading problems than the novice participants. This effect held true even when participants were warned not to use their baseball knowledge. Thus, domain knowledge in “experts” can lead to the retrieval of different information than “novices.” Sometimes this can be useful, especially in situations where there is a need for experts’ domain knowledge. However, as Wiley’s study showed, domain knowledge can implicitly be retrieved and applied in inappropriate situations, leading to fixation.

Fixation due to domain knowledge can also arise in a different manner. In attempts to create a new product, people will often use stored instances in their domain knowledge as a starting point. Ward (1994) showed that when participants were asked to create an imaginary creature on a different planet, they drew creatures that highly resembled earth-based animals. Fixation on earth-based animals is certainly the result of experience with these animals. The more interaction with these animals, the more the core features of these animals became conceptualized. Thus, when asked to create a novel creature, these features are quickly retrieved and the person becomes fixated upon the idea that this novel creature must have these features incorporated.

#### *Fixation Arising From Exposure to Stimuli*

As already reviewed, fixation can occur when attempting to use objects in an atypical fashion, when one inadvertently accesses information from one's knowledge domain, when attempting memory retrieval, and from recent experience. However, regarding the fixation literature, the topic of most concern for the present review is that of fixation arising from stimuli, because stimuli are experimentally manipulable, whereas domain knowledge is difficult to experimentally manipulate.

Jansson and Smith (1991) gave their participants engineering tasks to solve. In their series of experiments, half of the participants received an example diagram with multiple design flaws, while the control group received no diagram to preview. For example, the spill-proof coffee cup sketch was flawed in that it contained a straw and a mouthpiece. Participants receiving the example sketches were more likely to incorporate these obvious design flaws than participants in the control group as well as

have their sketches rated as being overall less creative than sketches produced by participants not receiving example sketches. This main effect was observed across a variety of engineering problems and when the flaws were also pointed out to participants. Even when using professional engineers as participants, the fixation group incorporated more negative aspects of the example than the control group.

This design fixation effect was replicated in two other studies (Chrysikou & Weisberg, 2005; Purcell, Williams, Gero, & Colbron, 1993). Purcell et al. gave their participants the measuring cup for the blind engineering problem (Jansson & Smith, 1991). Participants for this experiment were comprised of mechanical engineering students and interior design students. A total of four groups were created by dividing these two populations into control groups and experimental groups. The control groups were given a verbal description of the problem, while the experimental groups were given the verbal description and an example sketch containing numerous design flaws. No surface fixation occurred, meaning that participants didn't simply copy the example sketch. However, fixation effects at the analogical level were found with the mechanical engineering students. That is, among this population, the experimental group incorporated more underlying features of the example than the control group. This effect was not found with the interior design student population. From these results, we can reason that fixation resulting from stimuli/examples is more likely to occur in cases where the person is familiar with the principles at hand.

Chrisikou and Weisberg (2005) further examined negative transfer effects resulting from stimuli/examples presented to people engaged in ideation. Three groups

of participants were given the bike rack problem and the coffee cup problem from the Jansson and Smith (1991) study. The fixation group received a flawed example sketch with a description of its elements. The defixation group received the same flawed example, but also instructions to avoid its problematic elements. The control group did not receive a sketch or a description. Like the Purcell et al. (1993) study, direct similarities between the participant-generated sketches and the example were negligible. However, there were more underlying similarities in the fixation group. The number of underlying similarities decreased in the defixation group, followed by the control group. Thus, Chrisikou and Weisberg were able to replicate the Jansson and Smith (1991) finding of design fixation, but were also able to demonstrate a reduction in fixation by making the design flaws more salient.

Fixation from examples can also arise in creative generation tasks. Similar to the Ward (1994) study, an experiment asked participants to generate novel toys or alien creatures (Smith, Ward, & Schumacher, 1993). In the experimental group, participants were given examples of the toys/creatures. Participants in the experimental group conformed to examples statistically more than control group, which was not exposed to any examples. Even when told in a later experiment to diverge as much as possible from the examples, participants still conformed to the present examples.

In the research reviewed so far, it appears that providing a person with an example during ideation leads to the person becoming fixated on the example. According to the Roadmaps (Smith, 1995a) and Path of Least Resistance (Ward, 1994, 1995; Ward & Sifonis, 1997) models of creativity, the individual is stuck on a failed, conceptualized solution. In order to reach the correct solution, a person must move “up”

in the hierarchy (abstraction) and access other domains. It is possible that accessing multiple examples will prevent a person from becoming fixated on a single, failed solution. Dahl and Moreau (2002) did a series of experiments in order to gain a better understanding of how multiple analogies facilitate originality in design. In the first experiment they found that the percentage of analogies used had a positive significant effect on the originality of the product design. For Experiment 2, participants were either encouraged to think of one similar existing product or to think of as many different similar existing products as possible to give them ideas in solving the present design problem. This variable was crossed with whether or not participants were given an example sketch to view. Participants receiving the no example-multiple analogies manipulation produced the most original designs. The presence of the example did not reduce participants' ability to access multiple domains, but it did reduce originality of their sketches via conformity to the example provided. In experiment 3, participants were given one example sketch, four example sketches, or no example. Dahl and Moreau were interested in seeing how this manipulation affected the type of analogies used. Exposure to examples led to a higher use of "near analogies" (mapping of surface-level features). Participants who did not receive an example sketch used more "far analogies" (conceptual mapping) and more original products. From these experiments, Dahl and Moreau demonstrated that simply asking participants to use many base domains increased the number of analogies drawn and the originality of the product. However, if examples were provided to participants, the number of analogies used did not increase originality. Thus, it appears that creative ideation is best served by



promoting the access of multiple domains; however, it should not be promoted via provided examples.

### *Conformity*

Conformity effects/fixation does appear to be quite prevalent in creative engineering design. However, a question arises – do we also find conformity effects in other forms of novel creation? In these design studies, participants had some existing domain knowledge relevant to the design problem. Marsh, Ward, and Landau (1999) attempted to detect subtle influences of plagiarism in novel generation tasks where participants had no prior stored knowledge relevant to the task. Participants were first exposed to nonwords paired with real category exemplars (e.g., for the category of clothing, *shirt* was paired with *beang*). After learning these word pairs, participants generated their own nonwords to new exemplars. They were also instructed to avoid using features of nonwords they already saw. Conformity (e.g., syllable length, ending in “e”) was greater for participants who received nonwords that had a consistent rule pattern inherent in the presented nonwords than participants who were exposed to nonwords containing so such rule pattern. This is an important finding because it demonstrates that people unknowingly apply information they picked up through statistical learning and are unable to avoid applying it even when instructed to do so. These findings match that of an earlier study (Marsh et al., 1997) that unconscious plagiarism is more likely to occur in creative ideation than in other cognitive tasks (e.g., recognition memory).

Taken together, the research on stimuli leading to fixation is quite clear. In the case where people are asked to design a new product, they are very vulnerable to the influence of provided examples. Whether the examples provided contain useful concepts or design flaws, people will map these features onto their own design, even when instructed not to. It does not appear that participants in these experiments are simply replicating the example into their own sketch. Conformity effects are appearing deeper, at the analogical level. We are more likely to observe design fixation when the individual is familiar with the type of design problem at hand, and we are less likely to observe design fixation if participants are explicitly instructed to avoid specific features. Lastly, we are less likely to observe design fixation/conformity effects if people are allowed to think of their own relevant examples rather than presented with concrete examples. These findings can be modeled by the Roadmaps model of creativity (Smith, 1995a). If presented with a specific example, fixation occurs due to recent experience with this example. However, if no examples are provided, the person is free to move through the generative search, accessing multiple domains, and hopefully move closer to an adequate solution.

Thus, from the research reviewed on this topic, we can state that fixation/conformity effects/unconscious plagiarism is prevalent in creative ideation. Through exposure with stimuli relevant to the task at hand, people quickly learn this information. Unknowingly and typically against their will, they retrieve this information as a first step in creative ideation.

## Resolving Fixation

As already discussed, fixation can have detrimental effects on creative problem solving. However, the occurrence of fixation during ideation does not preclude an adequate solution from being obtained. The next section will discuss ways in which fixation can be countered.

### *Insight*

In Graham Wallas's (1926) model of creativity, he described a stage called *illumination*, in which the solution to the problem suddenly flashes into conscious thought. This event is more commonly referred to as *insight*. The Gestaltists were among the first to bring attention to insight. They viewed insight in problem solving as the recognizing a gestalt or organizing principle in the problem. There was some dispute within the Gestalt camp regarding insight (Mayer, 1995). Gestaltists made many seminal observations regarding visual perception and illusions. This extended into insight. Kohler focused on insight as a rapid reorganization of visual information. He even observed this among non-human animals. In the book, *The Mentality of Apes* (Kohler, 1925), he found that his chimp, Sultan, would exhibit insight by suddenly piecing two sticks together to gain access to a banana that was out of reach. Other Gestaltists saw insight as not one act, but rather a succession of reformulating the problem. Sometimes these successions are a result of suggestion from outside sources. Still another view of insight was that problem solution was achieved when a person realized an analogy could lead to solution. In this scenario, the individual applies the knowledge of the structural organization of one problem/scenario and applies it to

another. This is the basis for many of the later analogy transfer experiments previously discussed (Gick & Holyoak, 1983). The other major view of insight in the Gestalt camp was that of insight as overcoming mental blocks. Mental blocks arise due to inappropriate past experience (e.g., functional fixedness, mental sets). Once the person is able to overcome the mental block, insight and solution occurs rapidly.

The Gestalt psychologists laid the groundwork for insight research with their observations. However, making observations and guessing that insight occurred is not enough to prove that insight is an actual psychological phenomenon. Over the past 20 years, more scientific approaches have provided supportive evidence for the existence of insight.

One of the largest questions surrounding insight is whether or not it is a cognitive process akin to normal problem solving and memory retrieval. A series of studies were performed to try and understand the difference between insight and other cognitive processes (Metcalf, 1986a, 1986b; Metcalf & Wiebe, 1987). Participants were given insight problems, noninsight problems, and memory retrieval tests. In some experiments they were asked to estimate how likely they are to solve the problem/retrieve the item from memory (Metcalf, 1986a). It was found that there was a positive correlation between their estimate of memory performance and actual successful retrieval. No correlation was found between their estimate and performance on insight problem solving. Additionally, participants tended to greatly overestimate their ability to solve these insight problems. Thus, it appears that participants are unable to predict if they will be successful in solving an atypical problem. In another set of experiments,

participants were asked to solve insight problems while concurrently giving warmth ratings every 10 seconds as to how close they felt they were to a solution (Metcalf, 1986b). For problems in which the participants were successful in solving, they did not show a linear increase in warmth ratings. Rather, they did not feel like they were approaching solution until immediately prior to solution when they had a sudden increase in warmth ratings. Warmth ratings were further compared between insight and noninsight problems (Metcalf & Wiebe, 1987). Participants were given both types of problems and asked to give warmth ratings every 15 seconds. For noninsight problems, participants had a gradual incremental pattern of warmth ratings. For insight problems, participants showed a much more sudden rise in warmth ratings immediately preceding solution. Furthermore, participants are better predictors of success on noninsight problems than on insight problems. Taken together, these three studies offer evidence that insight is not the same as typical problem solving. People are not accurate in their predictions of being able to solve insight problems. During their search for a solution, they do not feel that they are drawing closer to the solution until it instantly flashes into consciousness.

Another source of evidence for the validity of insight is from neuroimaging studies. Using neuroimaging techniques, questions regarding insight can be further examined, such as whether or not insight is different from normal problem solving. Jung-Beeman et al. (2004) studied insight by giving participants RAT problems while connected to either an *fMRI* or an EEG machine. They found that the right hemisphere anterior superior temporal gyrus (RH aSTG) had greater activation in insight solutions

than noninsight solutions. Additionally, they found that there was a burst of gamma-band activity with correct insight solutions just prior to the participant solving the RAT problem. This was not found with noninsight solutions. This burst was found in the right hemisphere. From these two findings, the authors argue that the sudden rise in activity reflects sudden emergence of the solution into consciousness and that the RH aSTG allows for integration of distant semantic relations. A subsequent study found that whether or not insight will be used to solve a problem depends upon brain activation prior to problem presentation (Kounios et al., 2006). They came to this conclusion by giving participants RAT problems (able to be solved via insight or noninsight processing) and studying the brain using *fMRI* and EEG. Compared to using noninsight processing, there was distinctly different activation patterns prior to solving insight problems in the anterior cingulate cortex. Thus, it appears that the mind uses preparatory mechanisms that modulate whether or not insight will occur in the problem that is about to be attempted.

While the existence of insight, at least the way in which it was originally described by the Gestaltists, is not completely certain, the evidence seems to support it. When engaged in creative problem solving in which there is not a clear path towards solution, a person does not realize they are approaching the answer. However, something occurs in which the solution suddenly crosses into conscious threshold. This event is accompanied by a change in brain activation. For simplicity purposes, we will refer to the combination of these events as *insight*. This dissertation; however, is not focused on an examination of insight. For a more thorough review, please see Sternberg

and Davidson's (1995) text. What is important is that insight does seem to occur. The next logical question regarding creative problem solving is what facilitates insight in problem solving?

### *Incubation Effects*

Another way in which fixation can be overcome is through incubation effects. Incubation is a term popularized in the 1920's to refer to laying aside a problem as a step towards solution (Wallas, 1926; Woodworth & Schlosberg, 1954). By its very nature, the concept of incubation is counter-intuitive. If a person wants to succeed in solving a problem, retrieve a memory, or be creative, they should continuously work towards achieving their goal.

Incubation intervals have been found to promote solution on insight problems (Goldman, Wolters, & Winograd, 1992; Penney, Godsell, Scott, & Balsom, 2004; Segal, 2004; Smith & Blankenship, 1989). For example, in the Segal study, participants were given a geometric figure and asked to find the area of a geometric figure. This problem is typical of an insight problem, requiring the person to restructure the problem and think of the geometric figure in a nontraditional way. When participants reached an impasse in solving the problem, they were either given a break with an intervening task or they were asked to continue solution attempts. It was found that participants who received the incubation interval were significantly more likely to resolve the insight problem than were participants who attempted to solve it without interruption.

Memory retrieval also benefits from incubation intervals. As previously mentioned, the Smith and Vela (1991) study examined how incubation intervals affect

reminiscence. Participants were able to recall more items from a list when there was a break between their two recall attempts than when the second recall test immediately followed the first recall test. Thus, not only does an incubation interval allow you to have a “fresh perspective” on an insight problem, it can allow you to have a fresh attempt at retrieving items from memory. The theoretical mechanisms for problem solving and memory retrieval are quite similar. Fixation in problem solving is occurring due to aspects of the problem being encoded in only one way. Output interference in memory retrieval is occurring because the present memory probe is only able to sample part of the items in memory. An incubation interval can provide a temporal and/or spatial context change allowing for different aspects/items to be coded/sampled.

It is worth noting that incubation effects are not universally found. Gall and Mendelsohn (1967) examined the effect of incubation, free-association training, and continuous work on solving problems. They found in all instances that continuous work was as good or better than an incubation period. Dominowski and Jenrick (1972) also found that an incubation period could be detrimental to problem resolution; however their result is dependent upon the person’s cognitive ability. Other research simply found no effects of incubation intervals and concluded that incubation may not exist (Olton, 1979; Olton & Johnson, 1976).

However, the literature on incubation does appear to be much more supportive for the phenomenon that incubation effects do exist (Browne & Cruse, 1988; Goldman et al., 1992; Patrick, 1986; Silveira, 1971; Smith & Blankenship, 1989, 1991). A review of incubation effects (Dodds, Ward, & Smith, 2003) draws the conclusions that incubation



effects are very much real. Furthermore, longer periods of preparation increase the benefits of incubation intervals. It is worth noting that incubation effects have been shown to be effective in eliminating memory blocks (Smith & Blankenship, 1991), solving insight problems (Segal, 2004) and puzzles (Smith & Blankenship, 1989), and overcoming output interference (Smith & Vela, 1991). Yet, incubation periods have not been examined as a means to overcome conformity like the experiments reviewed in this paper.

#### *Forgetting Fixation Theory of Incubation*

So, if incubation intervals do lead to productivity gains, then the next logical question is what is actually occurring during incubation? Is there a sudden transformation of the problem as theorized by the Gestaltists? If so, what is causing this transformation? Are incubation effects really artificial? For example, could it be that people are still consciously processing the problem, but in a more relaxed atmosphere? Are people acquiring relevant information or cues during the interval that are allowing them to solve the problem or retrieve the desired memory? Or is it that people have removed a mental block that is impeding their solution/retrieval efforts? There are a number of different theories regarding incubation effects. I will now focus on one of the more plausible ones.

The *Forgetting Fixation Theory* of incubation stems from the early view of incubation that false assumptions are blocking the user from solving the problem (Woodworth & Schlosberg, 1954). There are two variants of this theory. According to this blocking version, the initial attempt at solving a problem is thwarted due to a person

being fixated on a mental block (Smith, 1995b; Smith & Blankenship, 1991). An incubation interval allows a person to forget this fixating block and allow the correct solution to be accessed. Fixation can occur via a number of ways (e.g., recent experience, false assumptions). For example, fixation might occur when the problem activates the solution as well as multiple competing associates. One of these associates gets sampled from memory. This sampling causes the strength between the cue (problem) and the blocker (competing associate) to become strengthened. Thus, the person becomes fixated on the blocker. An incubation interval will be effective in resolving the problem to the extent that the interval allows the person to forget the blocker. That way, when the person revisits the problem, the competing associate's activation level will return to baseline and thus increase the probability that the correct answer will be sampled. There has been some supportive evidence for the Forgetting Fixation Theory. In Smith and Blankenship's (1991) study, they gave participants RAT problems and induced fixation by pairing these problems with words that either fixating or unrelated to the words in the RAT problem. For example, the RAT problem ARM COAL PEACH (solution: "Pit") might be paired with leg, furnace, and pear (related) or with election, belly, and football (unrelated). They found that fixation decreased performance on initial RAT solution attempts. However, trials in which fixation was induced benefited the most from incubation intervals. Thus, it appears that the beneficial value of incubation intervals stems from their ability to release a person from temporary fixation.

Additional supportive evidence comes from Vul and Pashler's (2007) study that sought to test if incubation effects occur from subconscious work or from the removal of fixation. They only found incubation effects when fixation was experimentally induced using a paradigm similar to Smith and Blankenship (1991). Thus, it appears that fixation may be a requirement for incubation effects. It is worth noting that some studies have shown incubation effects in cases where fixation was not induced by the experimenter. However, this does not mean that self-induced fixation did not occur.

The other variation of the Forgetting Fixation Theory concerns how the problem is coded. In this situation, there is no specific mental block that is impeding progress towards solution. Rather, the issue is that the problem was encoded the wrong way. An incubation interval allows a person to encode the problem in a different, more appropriate way that will lead to solution. This version of the theory stems from the theory of encoding variability. If a to-be-remembered (TBR) item is encoded in a single massed presentation, then this TBR item will be encoded in only one context and will be only be thought of in one way. However, if the TBR item undergoes distributed encoding in which the user is presented the item multiple times, then it is more likely to be encoded in multiple contexts. For example, if the TBR item is a stapler and the item is presented in one, massed presentation, then the person is likely to think of the stapler as having only one use (e.g., fastening pieces of paper together). However, if it is presented in multiple presentations in different contexts, then person is likely to encode the stapler as having multiple functions (e.g., paperweight, pendulum, paper fastener, etc.). So, if a problem is only presented in one context during solution attempts and that

context is inappropriate, then it is likely that the person will become fixated on the wrong path towards solution. This fixation can be overcome with a long incubation interval. The longer the interval, the more likely the context surrounding the problem will change and thus it will be encoded differently.

At first glance it might seem confusing that according to the Forgetting Fixation theory, an incubation interval's benefits are that it allows you to forget something (fixating blocker) and to remember something else (TBR item). However it makes more sense when it is viewed in terms of the stimulus sampling theory. What is sampled from memory changes with time and/or context. Initial solution/retrieval attempts fail because of the presence of a fixating element that is being sampled. With a change in context (provided by an incubation interval), different elements from long-term memory get sampled. The fixating element becomes "forgotten" and the appropriate, targeted information is retrieved.

Supportive evidence for this encoding version of the theory comes from a previous Smith and Blankenship (1989) study of incubation effects. Participants were given rebus problems with a misleading clue. The length of incubation was manipulated between-subjects (0, 5, or 15mins). Participants then had a second solution opportunity for the rebus problem as well as a memory test for the clue that was presented with the problem. It was found that as time increased, resolution of the problem increased roughly at the same rate as memory for the misleading clue decreased. This finding supports the idea that in cases where the problem was incorrectly encoded in initial presentation, longer incubation intervals promote resolution via a change of context.

Although incubation effects are not completely understood, we can conclude that they have an important place in creative problem solving. When a person is unable to solve a problem due to fixation, an incubation interval can be helpful in aiding resolution of the problem. It is important to note; however, that entering an incubation interval does not guarantee that the problem will be resolved. In reality, the incubation period can provide a setting that will make resolution *more likely* to occur.

### Fixation in Brainstorming

As reviewed, there are several possible reasons why group brainstorming is less effective than individual brainstorming. Production blocking, social loafing, evaluation apprehension, and downwards matching have received the most attention. Thus, depending upon the situation, there may be one or multiple causes leading to productivity deficits. Some modifications to group brainstorming meant to minimize these causes have led to increased performance among groups. However, in almost every case, nominal groups still outperform real brainstorming groups. It is possible that there is another factor at work that is preventing groups from reaching their full potential. This section will examine the possibility that fixation is occurring in brainstorming groups.

Fixation in brainstorming groups is a topic that has not been given any attention with the exception of a brief mention in a chapter on fixation. Smith theorized that “seeing or hearing the ideas of others in one’s group would likewise constrain idea generation in group participants” (2003, p. 29). While exposure to others’ ideas can have beneficial effects (e.g., piggybacking), it can also have unintended consequences.

A person in a group can hear a fellow member's idea and have their train-of-thought fixated on aspects of that other member's idea. This can be especially damaging if the proposed idea is a flawed one. Also, if the purpose of the present brainstorming session is to generate as many different possible ideas, fixation will lead to a decline in productivity.

#### *Potential Sources of Fixation*

The theoretical aspects of fixation in group brainstorming are very similar to that of fixation in individual creative problem solving. A stimulus is introduced to a person and as a result they can become fixated upon it. In group brainstorming, a group member might contribute an idea and as a result other group members become fixated on this idea. Thus, the difference between fixation in individual ideation and group brainstorming is the source of the fixating stimulus. With individual problem solving it could arise from an example or prior experience, whereas with group brainstorming it is likely to arise from contributions of a fellow group member. Therefore, fixation in brainstorming might look different from fixation in an individual setting (e.g., stuck on an incorrect path to solving an insight problem). It would take the appearance of conformity. Instead of a group exploring a diverse domain of ideas, the contributions of group members would conform to one another. The suggested idea(s) of a group member could be traced back to an idea previously suggested by another group member. Thus, the presence of fixation in an interacting group would be indicated by their ideas being quite similar to one another and the reduction in the breadth of categories explored

There is another contributing factor of fixation in group brainstorming. Group members are often forced to wait their turn to speak due to production blocking. They are likely to spend this time rehearsing their own idea so that it is not forgotten, especially if they highly value their idea (Diehl & Stroebe, 1991). Thus, it is possible that the more this idea is rehearsed in short-term memory, the more likely this person will remain fixated on the idea even after he or she has had their chance to verbalize it. So, in the case where production blocking is likely to occur (non-EBS settings), fixation would be exacerbated.

#### *Ways to Overcome Fixation*

Like fixation in individual problem solving, it is proposed that fixation arising in group brainstorming can be overcome. To overcome fixation in individual problem solving, the present situation has to change. This can happen in a number of different ways. Relevant hints/stimuli could be accessed that would spark insight (Seifert et al., 1995). Recent experience with a fixating element/stimulus could dissipate with time or a context change could allow the problem to be coded differently and/or change which items from long-term memory get sampled (Smith, 1995b). To reduce fixation in brainstorming groups, one should apply the same principles from the individual level to that of the group level (providing helpful stimuli and/or a context change).

As mentioned earlier, incubation intervals can be helpful in overcoming temporary fixation on individual problem solving. Theoretically, an incubation interval should also aid a group brainstorming session. If a group is fixated on the wrong path in trying to solve a specific problem or feel like they are unable to generate any more ideas,

an incubation interval would likely be beneficial. Paulus et al. (2006) looked at the effect of breaks on individual written brainstorming. Participants in the one-break condition did 15 minutes of brainstorming, 6 minutes of relaxation, and then 15 more minutes of brainstorming. Participants in the two-break condition did 10 minutes of brainstorming, 3 minutes of relaxation, 10 minutes of brainstorming, 3 minutes of relaxation, and then 10 more minutes of brainstorming. In the no-break condition, participants engaged in 36 minutes of continuous brainstorming. When comparing the last 10 minutes of each session, Paulus et al. found that participants in the break conditions generated more ideas than those in the no-break condition. There was no difference between the two experimental break conditions. Paulus et al. repeated this experiment, but with participants typing their ideas onto a computer (to simulate EBS). In this experiment, the break conditions again yielded more ideas than the no-break condition; however, it did not reach significance. This set of experiments appears to show that incubation effects can be found in brainstorming activities. However, there are a couple points worth mentioning regarding this study. First, their results may be flawed because participants in the no-break condition spent 6 more minutes generating ideas than participants in the experimental break conditions before the 10 minute period (where ideas were counted for analysis). It is possible that participants in the no-break condition may have more thoroughly exhausted their ideas by that point due to the additional time. Secondly, this study showed incubation effects for individual brainstorming. While theoretically incubation effects should also occur in group brainstorming, no experiments to my knowledge have tested this. Therefore, incubation



in group brainstorming is a topic that needs more attention before any conclusions should be made.

### Proposal

In the present review, I have examined the literature on fixation and brainstorming. While these two topics have much in common, there has not been any prior research concerning the synthesis of fixation and brainstorming. The purpose of this review is to propose a new hypothesis – fixation is a contributing factor to the productivity deficit found in group brainstorming. This is not to say that fixation is the only factor leading nominal brainstorming groups to outperform real groups. Research has shown that the productivity deficit is multiply-caused (e.g., production blocking and social factors). Rather, I propose that fixation also contributes to groups not performing up to potential. Three experiments tested this hypothesis. In Experiment 1, an attempt was made to replicate the productivity deficit in regards to nominal groups generating more ideas than real groups. Additionally, by measuring other dependent variables such as variety and novelty, indirect evidence of fixation could be observed. A group that has become fixated should be more likely to limit their idea generation to fewer categories because they are “stuck” on these categories. Experiment 2 sought to further investigate if the idea exchange process that takes place in brainstorming groups can lead to fixation. To do this, the ideas participants were exposed to were controlled by employing a confederate. The last experiment looked to alleviate fixation in brainstorming by using an incubation interval.

## CHAPTER II

### EXPERIMENT 1

#### Introduction

The primary purpose of Experiment 1 was to obtain normative data on individual and group brainstorming. Experiments 2 and 3 compared production rates to the norms found in Experiment 1. Additionally, in Experiments 2 and 3, fixating stimuli was presented to participants. Fixating stimuli consisted of highly typical solution ideas to the brainstorming topic. In order to determine which ideas are typical, Experiment 1 examined which ideas are produced most frequently by participants in the nominal condition. The secondary purpose of Experiment 1 was to assess how different brainstorming settings (group versus individually) influenced the quantity, variety, and novelty of ideas generated. Therefore, in Experiment 1, participants simply worked either individually (nominal condition) or in groups on generating ideas to the brainstorming topic. It was predicted that a productivity deficit would be observed (more ideas generated in the nominal condition than in the real group condition). Additionally, participants brainstorming individually would have a greater variety of ideas (number of categories explored) as well as generate more novel ideas. The data in Experiment 1 was analyzed temporally. The vast majority of brainstorming research has simply looked at the total number of ideas generated during the session. Experiment 1 examined how quantity, variety, and novelty fluctuate over time in the two types of brainstorming sessions. This was conducted so as to better understand the productivity deficit as well as fixation in brainstorming.

## Method

### *Participants*

Participants for this study originated from an introductory psychology course. For their participation they received credit towards their experimental participation requirement of the course. They had the option of signing up for this experiment as well as numerous others. A total of 160 participants volunteered for this experiment.

### *Materials*

To conduct Experiment 1, four computer terminals were used. Each terminal had its own personal computer and monitor. AOL Instant Messenger (AIM) was the software medium for the electronic brainstorming.

### *Design and Procedure*

For this experiment, participants were divided into two conditions: nominal and real. In the nominal condition, participants worked individually on the brainstorming task. For each nominal session, there were 2-4 participants present in the room. In the real condition, 4 participants worked together on a group brainstorming task. For both conditions, participants were seated at computer terminals in the same room, separated by divider walls that prevented visible contact with other participants.

Upon arrival, participants received instructions on brainstorming as well as a modified version of Osborn's (1957) brainstorming rules: (a) Criticism is ruled out, (b) Freewheeling is welcomed, (c) Quantity is wanted, (d) Combination and improvement are sought, and (e) Stay focused on the task. Next, participants were given one minute to read the brainstorming topic ("List ways in which to improve Texas A&M University").

Similar topics have been used in other brainstorming studies (Marsh, Landau, & Hicks, 1997; Paulus, Nakui, Putman, & Brown, 2006). They then spent the next 20 minutes generating as many ideas as possible using an electronic brainstorming (EBS) medium. The software program, AOL Instant Messenger (AIM) was used to collect ideas (see Figure 1). For the nominal condition, participants typed in their ideas and transmitted them to the experimenter's computer by pressing the 'Enter' key. They received no communication or feedback from the experimenter during brainstorming. In the real condition, participants communicated with each other using the "Chat" feature of AIM. This allowed participants to see each others' ideas as they were submitted. Participants were not aware of which person in the room submitted each idea because each person was assigned a random ID. For both conditions, AIM allows the experimenter to record the ideas submitted, which participant submitted the idea (applicable only to the group condition), and at what time the idea was submitted. Upon the conclusion of the brainstorming session, participants in both conditions were given a subjective report. This asked participants to rate how easy/difficult it was for them to generate ideas different from their own (on a 10-point scale); and in the group condition – how easy/difficult it was for them to generate ideas different from other members (on a 10-point scale).

## Results

### *Coding*

For both conditions, experimenters coded each idea generated as belonging to one of 30 possible categories of ideas (see Appendix B for category list). The creation

of categories for classification has been used on a previous brainstorming study that used a similar topic (Baruah & Paulus, in press). On the rare occurrence that a submitted entry contained two ideas, this entry was divided and categorized appropriately (e.g., “Fix the sidewalks and tear down the old buildings” would be coded as two ideas belonging to the categories “Improvements” and “Buildings,” respectively). Repetitious ideas or non-serious ideas were not included in any analysis. Interrater reliability for the number of included ideas, as measured by Cronbach’s alpha was .92.

To create nominal groups, the data from 4 random participants from the nominal condition were grouped together. These ideas were placed in temporal order (e.g., Participant A’s idea submitted at 14:15 was placed after Participant B’s idea submitted at 14:12). For both real groups and nominal groups, any ideas repeated by another participant were discarded.

To assess the creativity of participants’ responses, each idea was given a novelty score. The 80 participants in the nominal condition generated a total of 2,119 coded ideas that fell into the 30 categories (see Appendix B for a list of categories and frequency of ideas). Each category of idea was assigned a novelty score based on the following formula: novelty score of category Y =  $(2119 / \text{number of ideas falling within category Y}) / (2119 / 100)$ . Thus, the less frequent the category was explored by participants, the higher the novelty score. For example, “Food” was the most frequently occurring category of ideas (165 ideas) and therefore any idea coded as “Food” was assigned the lowest novelty score (0.6061).

As discussed below, several temporal analyses were performed. This was conducted by dividing each group's session (real and nominal) into four time quadrants: Q1[0:00-4:59], Q2[5:00-9:59], Q3[10:00-14:59], and Q4[15:00-20:00].

Unless specified, a  $p < .05$  was used as the criterion for significance for the following analyses.

### *Quantity*

To analyze how the group type influenced production, a 2 (group type: real vs. nominal) X 4 (time quadrant: Q1, Q2, Q3, Q4) ANOVA was calculated on the number of ideas generated. There was a main effect of group type [ $F(1, 38) = 13.04, MSE = 117.96$ ] with nominal groups ( $M = 25.74, SE = 1.21$ ) producing more ideas than real groups ( $M = 19.54, SE = 1.21$ ). The effect of time quadrant was also significant on the number of ideas produced [ $F(3, 114) = 161.35, MSE = 12.29$ ]. Pairwise tests (with a Bonferroni adjustment) revealed that there were significant differences between all four time quadrants, with the number of ideas produced decreasing with each successive time quadrant (see Figure 1). There was also a significant interaction between group type and time quadrant [ $F(3, 114) = 14.30, MSE = 12.29$ ]. Follow-up t-tests revealed that nominal groups generated more ideas than real groups during the first time quadrant [ $t(38) = 5.50, p = .00$ ], second time quadrant [ $t(38) = 3.17, p = .00$ ], and third time quadrant [ $t(38) = 2.16, p = .04$ ].

A t-test was also calculated to compare the number of ideas generated by a real group to that of a single participant (not a nominal group). Real groups ( $M = 78.15, SD$

= 22.49) generated more ideas than individual participants ( $M = 26.49, SD = 11.97$ );  $t(98) = 14.14, p = .00$ .

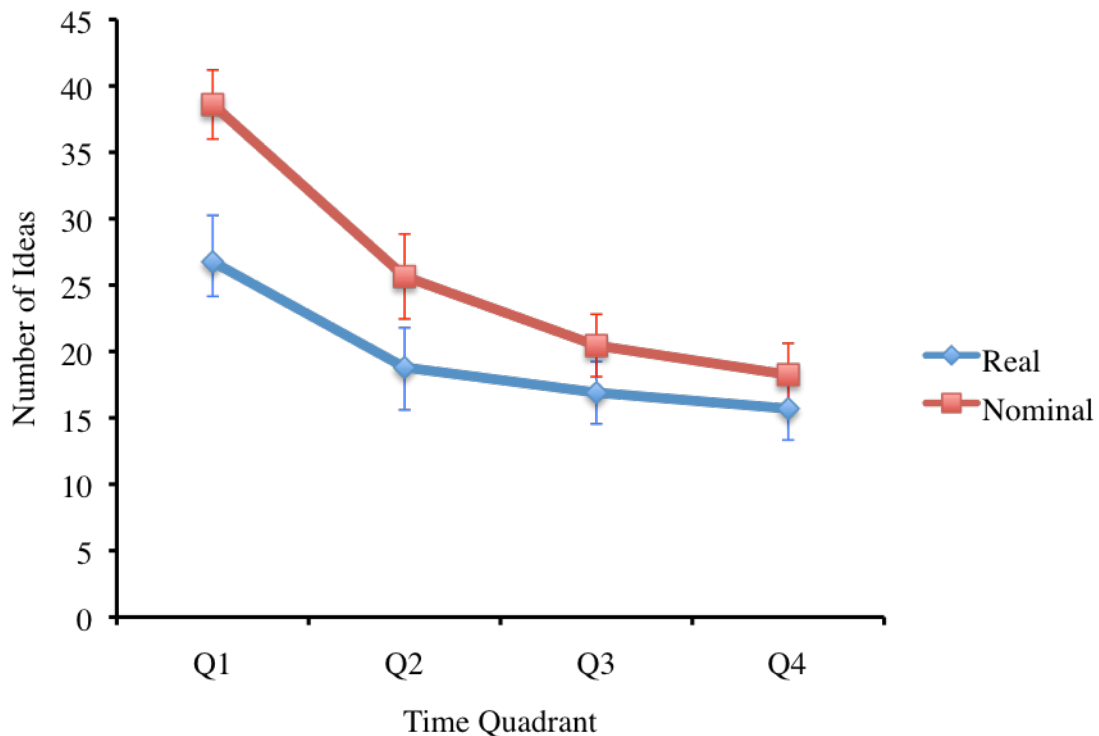


Figure 1. Quantity of ideas generated in Experiment 1.

### Variety

To analyze how the group type affected the variety of ideas generated, a 2 (group type: real vs. nominal) X 4 (time quadrant: Q1, Q2, Q3, Q4) ANOVA was calculated on the number of categories explored. There was a main effect of group type [ $F(1, 38) = 64.38, MSE = 13.58$ ] with the nominal groups ( $M = 13.63, SE = .41$ ) exploring more categories than the real groups ( $M = 8.95, SE = .41$ ). The effect of time was also

significant [ $F(3, 114) = 57.20, MSE = 3.87$ ]. Pairwise tests (with a Bonferroni adjustment) revealed that there were significant differences between all four time quadrants, with the number of categories explored decreasing with each successive time quadrant (see Figure 2). There was also a significant interaction between group type and time quadrant [ $F(3, 114) = 2.78, MSE = 3.87$ ]. Follow-up t-tests revealed that nominal groups generated more categories than real groups during the first time quadrant [ $t(38) = 7.72, p = .00$ ], second time quadrant [ $t(38) = 5.59, p = .00$ ], third time quadrant [ $t(38) = 5.50, p = .00$ ], and fourth time quadrant [ $t(38) = 5.16, p = .00$ ].

A t-test was also calculated to compare the number of categories explored by a real group to that of a single participant (not a nominal group). Real groups ( $M = 19.25, SD = 2.95$ ) explored more categories than individual participants ( $M = 13.05, SD = 4.02$ );  $t(98) = 6.47, p = .00$ .



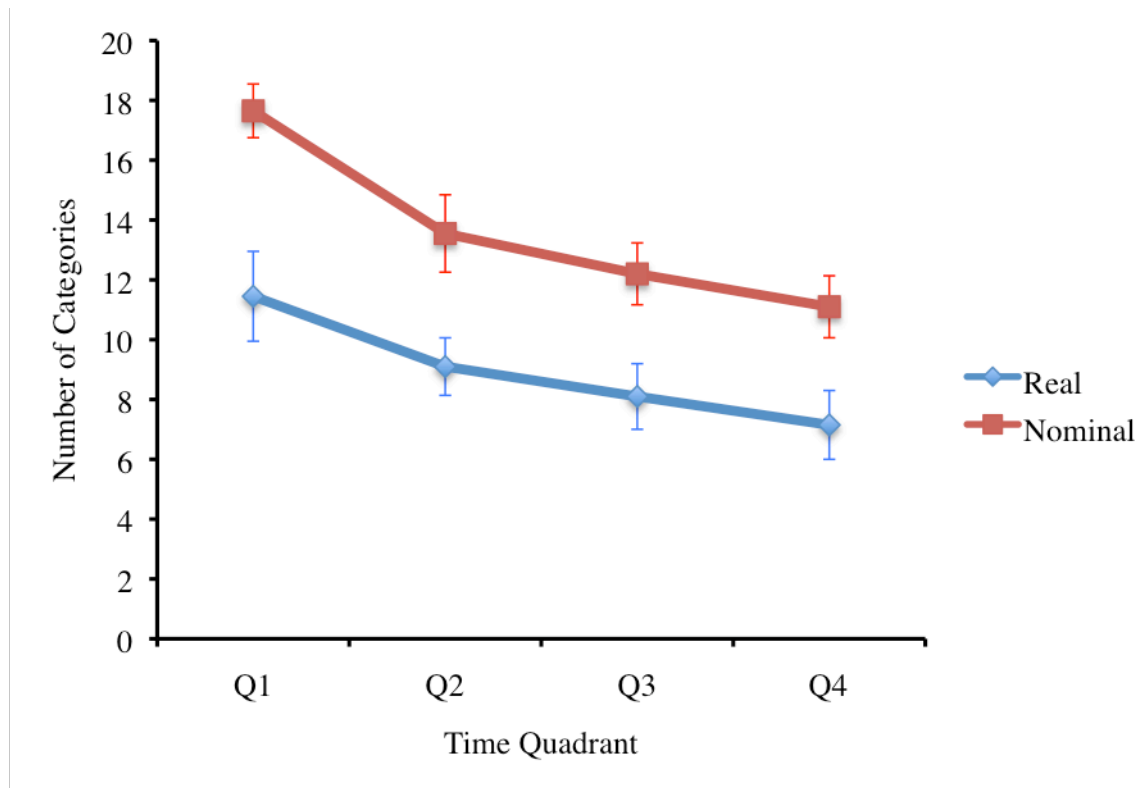


Figure 2. Variety of ideas generated in Experiment 1.

### Novelty

To assess novelty, a 2 (group type: real vs. nominal) X 4 (time quadrant: Q1, Q2, Q3, Q4) ANOVA analyzed the average novelty of participants' ideas. This dependent measure was calculated by averaging the novelty scores of the ideas generated in each individual time period. The effect of time was not quite significant [ $F(3, 114) = 1.81$ ,  $MSE = 0.62$ ,  $p = .15$ ]; however, there was a statistical trend of novelty scores increasing with each successive time quadrant (see Figure 3). There was no main effect of group type [ $F(1, 38) < .01$ ,  $MSE = 0.70$ ] and there was no significant interaction between group type and time quadrant [ $F(3, 114) = 0.73$ ,  $MSE = 0.62$ ].

A t-test was also calculated to compare the average novelty of ideas generated by a real group to that of a single participant (not a nominal group). There was no significant difference between real groups ( $M = 1.37, SD = 0.42$ ) and individual participants ( $M = 1.41, SD = 0.58$ ) on the average novelty of ideas;  $t(98) = 0.26, p = .80$ .

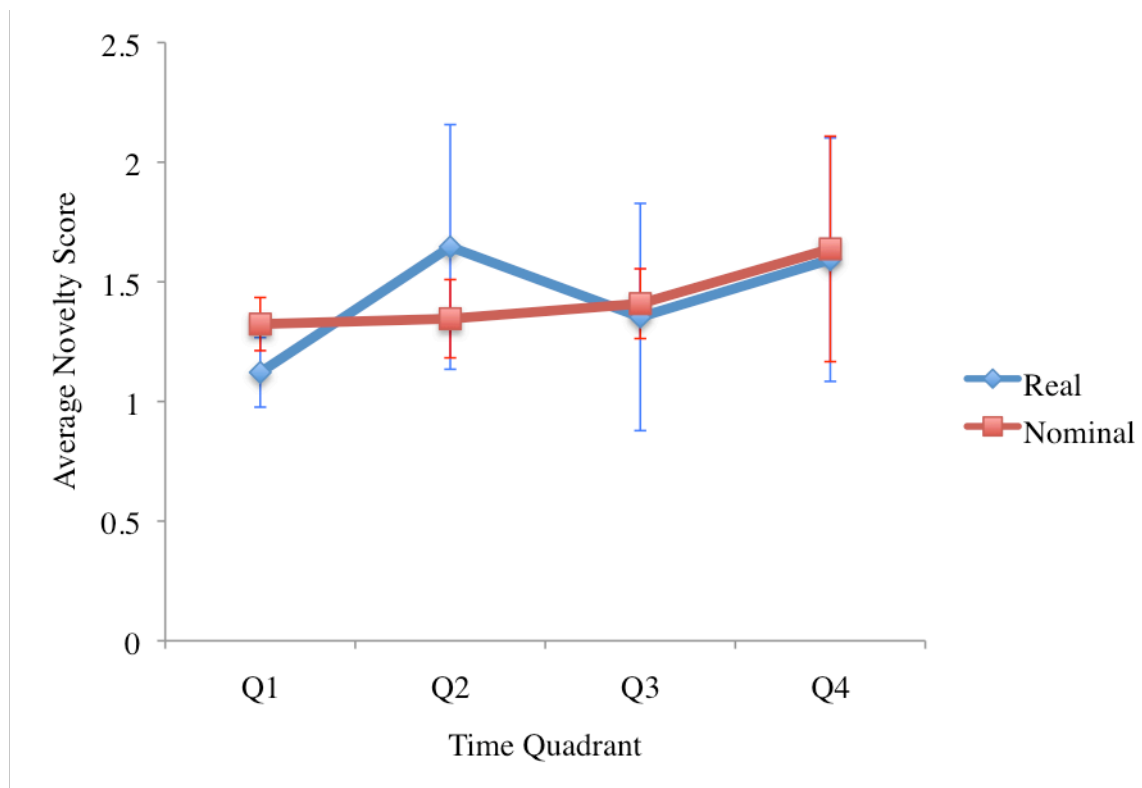


Figure 3. Average novelty score of ideas generated in Experiment 1.

To provide an additional indicator of novelty, an analysis was conducted on the “highest novelty”. This refers to the single idea with the highest novelty score generated during the entire 20-minute session. This analysis was conducted because in addition to knowing the average novelty of ideas, it is important to know what type of brainstorming

session leads to the single most original idea. A t-test compared real and nominal groups on highest novelty. There was no significant difference between real groups ( $M = 13.73$ ,  $SD = 12.36$ ) and nominal groups ( $M = 11.98$ ,  $SD = 9.19$ );  $t(38) = .51$ ,  $p = .61$ .

A t-test was also calculated to compare the idea with the highest novelty generated by a real group to that of a single participant (not a nominal group). Real groups ( $M = 13.73$ ,  $SD = 12.36$ ) had a greater highest novelty idea than individual participants ( $M = 5.26$ ,  $SD = 5.59$ );  $t(81) = 4.27$ ,  $p = .00$ .

### *New Categories*

To further explore the effect of the group type on the quantity and variety of ideas, an additional analysis was conducted that looked at new categories. New categories refer to a category of idea that had not previously been explored during the brainstorming session. For example, if a participant generated a “Sports” idea during the third time quadrant and no “Sports” ideas had been previously generated during the brainstorming session, then this would count as one new category for the third time quadrant. As a consequence of this method, the first time quadrant was not analyzed.

A 2 (group type: real vs. nominal) X 3 (time quadrant: Q2, Q3, Q4) ANOVA was calculated on the number of new categories explored. There was a main effect of group type [ $F(1, 38) = 6.02$ ,  $MSE = 1.51$ ] with the real groups ( $M = 7.80$ ,  $SE = .52$ ) exploring more new categories than the nominal groups ( $M = 6.15$ ,  $SE = .42$ ). The effect of time was also significant [ $F(2, 76) = 28.24$ ,  $MSE = 2.15$ ]. Pairwise tests (with a Bonferroni adjustment) revealed that there were significantly more new categories explored in the second time quadrant than the last two time quadrants (see Figure 4). There was no

significant interaction between group type and time quadrant [ $F(2, 76) = 0.22$ ,  $MSE = 2.15$ ]; however, t-tests revealed that real groups ( $M = 2.35$ ,  $SD = 1.66$ ) only explored a significantly greater number of new categories than nominal groups ( $M = 1.35$ ,  $SD = 1.04$ ) in the third time quadrant;  $t(38) = 2.28$ ,  $p = .03$ .

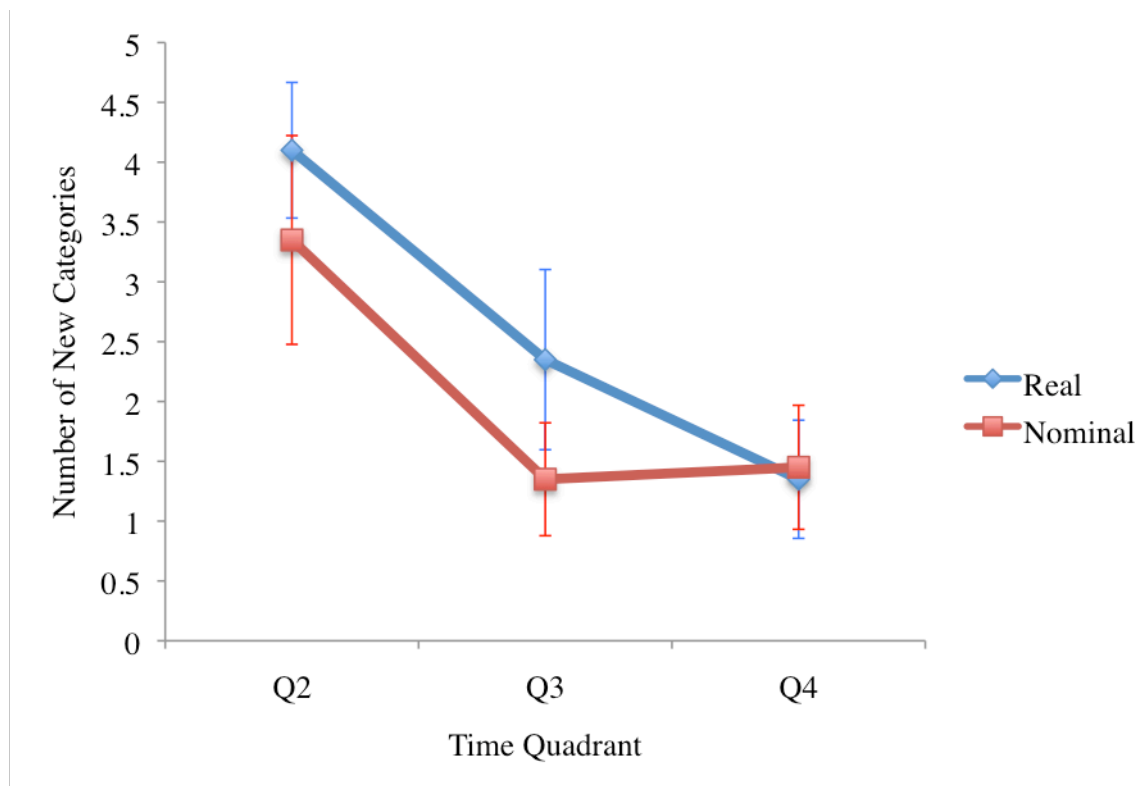


Figure 4. Number of new categories explored in Experiment 1.

### *Subjective Report*

To provide an indirect measure of fixation, the subjective reports were analyzed. When asked about the difficulty in generating ideas different from their previous submissions, nominal groups ( $M = 5.68$ ,  $SD = 0.99$ ) found this task to be more difficult

than real groups ( $M = 4.94, SD = 0.93$ );  $t(38) = 2.43, p = .02$ . A paired t-test revealed that participants in the real groups found it to be more difficult to generate ideas different from their other group members ( $M = 5.55, SD = 1.39$ ) than to generate ideas different from their own ( $M = 4.94, SD = 0.93$ );  $t(19) = 2.45, p = .02$ .

### *Demographic Analysis*

To analyze if the demographic composition of the real and nominal groups affected ideas generated, each group was coded as being composed of having members from one, two, three, or four academic backgrounds (schools within Texas A&M University). For example, a group comprised of members from the schools of Business, Engineering, Business, and Liberal Arts would be coded as a three-school group.

A 2 (group type: real vs. nominal) X 4 (demographic composition: one-school, two-schools, three-schools, four-schools) ANOVA was calculated on the number of ideas generated. There was no main effect of the demographic composition [ $F(3, 32) = 0.64, MSE = 528.16$ ] nor a significant interaction between group type and demographic composition [ $F(3, 32) = 0.04, MSE = 528.16$ ].

A 2 (group type: real vs. nominal) X 4 (demographic composition: one-school, two-schools, three-schools, four-schools) ANOVA was also calculated on the number of categories explored. There was no main effect of the demographic composition [ $F(3, 32) = 0.14, MSE = 8.48$ ] nor a significant interaction between group type and demographic composition [ $F(3, 32) = 0.08, MSE = 8.48$ ].

## Discussion

In Experiment 1, participants generated ideas either individually or in a group of four. It was predicted that nominal groups would generate more ideas, explore more categories, and have more novel ideas than real groups. Consistent with previous studies (Diehl & Stroebe, 1987, 1991; Gallupe et al., 1991; Mullen et al., 1991), a productivity deficit was observed in Experiment 1. Nominal groups generated more ideas than did real groups. By using a temporal analysis, the productivity deficit becomes clearer. During the first 5 minutes of the brainstorming session, nominal groups generated 44% more ideas than the real groups. However, over time this difference decreases. In the last 5 minutes of the session, nominal groups generated 16% more ideas than the real groups. This finding would seem to suggest that brainstorming sessions might be optimal if a group session follows an individual session, an idea opposite to unpublished research that found that a group-to-alone sequence led more overall ideas than an alone-to-group sequence (Putman, Paulus, & Leggett-Dugosh, 1999). There was some benefit to group brainstorming as a real group generated more ideas than a single individual. However, as described above, this advantage is reversed when a more fair comparison is made (nominal groups versus real groups).

The productivity deficit has always referred to the disparity in the number of ideas generated. Given the results of Experiment 1, a productivity deficit can also be seen in the number of categories explored. Nominal groups generated a wider variety of ideas than did real groups. It is believed that this is the first study to have examined and found nominal groups to have more variety than real groups. Previously, variety

analyses have been limited to finding that the number of categories explored increases with group size (Ziegler, Diehl, & Zijlstra, 2000). There was also a temporal effect on the number of categories explored. Participants explored the most categories in the beginning of the session and this number steadily decreased with time. Similar to quantity, the greatest disparity in variety between the nominal and real groups occurred in the beginning of the session (nominal groups generated 54% more categories in the first 5 minutes). However, unlike quantity, this disparity did not decrease over the course of the entire 20 minutes (nominal groups generated 55% more categories in the last 5 minutes). Again, there is some benefit to group brainstorming; a single real group does explore more categories than does a single individual.

To further investigate the difference between nominal and real groups in variety, an analysis was conducted on the number of new categories explored after the first 5 minutes. Real groups explored more new categories than did nominal groups over the following 10 minutes. This finding, coupled with the variety analysis means that during the last 15 minutes, nominal groups are generating ideas in more categories; however, they are more likely to generate ideas in the same categories as those previously explored. Conversely, with time, real groups are more likely to move onto new categories. It is just that they will not explore as many categories as will nominal groups.

The present experiment is believed to have been the first experiment to assess how the type of brainstorming setting (real vs. nominal) affects novelty. The impact of novelty has always been measured in terms of number of ideas explored (see Paulus,

2000 for a review of literature examining novelty). Experiment 1 used a non-objective measure of novelty by means of statistical infrequency. It was predicted that nominal groups would generate more novel ideas than would real groups. This was predicted because it was thought that the exchanging of ideas by members of a group would lead to conformity of domains explored, thus reducing the novelty of ideas. While the variety of categories was limited in a group setting, this did not result in a reduction in the novelty of ideas generated. Similar to the quantity and variety analyses, there is a benefit to group brainstorming; a single real group's most novel idea is rarer than a single individual's most novel idea. A trend was observed in that the average novelty increased with time (opposite trend to that of quantity and variety). Although the brainstorming task in the present experiment is different from the task of generating category members, these findings do mirror that of output dominance – category exemplars that most readily come to mind will be the first to be generated (Ward, Sifonis, & Wilkenfeld 1996). In Experiment 1, the most typical ideas were generated first and then later participants submitted rarer ideas. This has applied consequences. If the goal of a group is to generate a unique idea, then it is best that the brainstorming session is not too short.

The subjective report measures are not the most direct ways to examine if fixation is occurring; however, the reports do support the predictions. Individuals did find it harder than real groups to generate ideas different from their own previous submissions. If a single participant is asked to generate ideas on their own, then they will have a more limited set of domain knowledge than a group of four people.



Therefore, this individual is more likely to feel constrained by his or her own ideas. Real groups did report that it was more difficult to generate ideas different from their peers than it was to generate ideas different from their own. This is supportive of the thesis that in a group brainstorming setting, members become fixated upon the ideas of their peers.

One of the theoretical benefits of group brainstorming is that individuals from diverse backgrounds can come together to share their respective domain knowledge (Stasson & Bradshaw, 1995). Thus, more ideas and a wider range of ideas can be generated than a single individual. Analyses were conducted on how varying the homogeneity of a group influenced the quantity and variety of ideas. There were no main effects or interactions. This lack of an effect is in conjunction with a review (Paulus, 2000) that found homogeneity to not have a strong influence on production. However, this does not mean that a heterogeneous group will not lead to a greater number of ideas and a more diverse set of ideas. Because the make-up of a group was not the primary research focus of this study, the demographic composition of the groups was not systematically manipulated. Thus, there was unequal  $N$  across the comparisons and not enough power to detect any differences in the types of compositions.

Collectively, Experiment 1 provided some interesting findings. A productivity deficit was observed in that nominal groups generated more ideas than did real groups. As predicted, real groups had a more limited variety of ideas generated. This supports the thesis that the exchanging of ideas in a group setting leads to members becoming fixated on their peers' ideas, thus reducing the number of categories explored. However,

in order to fully understand how the exchanging of ideas influences subsequent idea generation, one must control the ideas that are exchanged. Experiment 2 addressed this issue.

## CHAPTER III

### EXPERIMENT 2

#### Introduction

The purpose of Experiment 2 was to explore the role of provocative stimuli in brainstorming in leading to fixation. It was hypothesized that an idea generated in a brainstorming group could cause other group members to become fixated upon this idea. Other group members' subsequent ideas would then contain elements of this original verbalized idea and would limit the domains explored by these other group members. In order to test this, Experiment 2 used a paradigm in which participants believe they are brainstorming with a partner. In reality, they were electronically interacting with a confederate. The confederate transmitted typical ideas (obtained from norms in the nominal condition of Experiment 1) to the participant during the course of the brainstorming session. The number of typical ideas (one, four, 10, or 20) transmitted to participants was manipulated between-subjects. This method was used so that the stimuli exposed to participants could be controlled. In the case of Experiment 2, the research question is concerned with how a participant would respond to exposure to typical ideas. By using a confederate (as opposed to studying a real brainstorming group), we can ensure that they are only exposed to the example ideas of interest (typical ideas). It was predicted that increasing the number of typical ideas received from the confederate would lead to a higher proportion of participants' ideas that belonged to these exemplified ideas. Furthermore, viewing more typical ideas from the confederate should lead to fewer categories being explored and a decrease in the originality of ideas.

Lastly, Experiment 2 explored whether or not fixation is a contributing factor in the brainstorming productivity deficit. It was predicted that the more ideas received from the confederate, the greater the fixation, and in turn, the fewer ideas generated by participants.

## Method

### *Participants*

Participants for this study originated from an introductory psychology course. For their participation they received credit towards their experimental participation requirement of the course. They had the option of signing up for this experiment as well as numerous others. A total of 86 participants volunteered for this experiment. Six participants' data were not included due to either a computer error or the participant being aware of the confederate. Of the remaining 80 participants, they were randomly assigned to one of the four conditions. None of the participants from Experiment 1 participated in Experiment 2. In addition to actual participants for this study, a confederate was used in this study. The confederate was a Caucasian male undergraduate student who fell in the same age range as the actual participants.

### *Materials*

Three computer terminals with AIM were used for Experiment 2.

### *Design and Procedure*

For this experiment, participants were evenly divided into four conditions: one-example, four-examples, ten-examples, or twenty-examples.

At the start of the experiment, the experimenter welcomed the participant and the confederate into the laboratory. Upon arrival, both the participant and the confederate received instructions that they would be brainstorming together on a topic using AOL Instant Messenger (AIM). Additionally, the instructions informed them that:

The program is set-up so that it will randomly screen-out some of your partner's ideas and some of your ideas. Although the experiment will record all of your ideas that you submit and all of the ideas that your partner submits, you will only be able to view some of your partner's ideas. Therefore, AIM will tell you when your partner is typing; however, it is possible that their idea may not appear in your chat window.

Included in these instructions were the same rules on brainstorming given in Experiment 1. Next, the participant and confederate were told that one of them would be randomly taken to the adjacent laboratory room that had a computer. The confederate was led to the adjacent room which had a computer with an AIM connection. A "group chat" session was established on AIM that included the experimenter's computer, the participant's computer, and the confederate's computer. After 1 minute, the experimenter returned to the original room and seated the participant at the computer terminal. Next, participants were given 1 minute to read the brainstorming topic ("List ways in which to improve Texas A&M University"). They then spent the next 20 minutes generating as many ideas as possible.

Upon conclusion of the experiment, participants were asked if they were aware that the other participant was a confederate. If they answered “yes,” then their data was not included in the analysis.

During the brainstorming session, the confederate transmitted ideas to the participant. Depending upon the condition, participants received one, four, 10, or 20 ideas. These ideas are from the categories that were the highest in frequency (most typical) based on the results from Experiment 1 (see Appendix B). For example, in the one-example condition, participants would receive only the idea “Add more busses to off-campus routes” from the category “Transportation.” If the participant had already generated this exact idea, an alternate idea from the same category was given (see Appendix C for a complete list of ideas given as well as the time they were submitted). In addition to submitting the ideas at the pre-determined times, the confederate would type something every 40 seconds and then delete it without submitting. Thus, the participant would see that the confederate was generating ideas throughout the duration of the brainstorming session. This was done to make the experiment more believable that the confederate was an actual participant and that AIM was randomly screening-out ideas.

Participants in the one-example condition received one idea from the Transportation category. Participants in the four-example condition received four ideas (one from the following categories: Transportation, Class, Food, Sports). Participants in the ten-examples condition received 10 ideas (one from the following categories: Transportation, Parking, Class, Improvements, Dorms, Food, Costs, Sports, Academics,

Buildings). Participants in the twenty-examples condition received two ideas from each of the 10 categories exemplified in the ten-examples condition (see Appendix B).

## Results

### *Coding*

Every idea generated by participants was classified as belonging to one of the 30 categories used in Experiment 1 (except for vague/uncodable ideas which were not included in the analyses). Instead of dividing the brainstorming session into four time quadrants, as was done in Experiment 1, Experiment 2 analyzed the data in terms of 10 2-minute time periods [0-1:59, 2:00-3:59, 4:00-5:59, 6:00-7:59, 8:00-9:59, 10:00-11:59, 12:00-13:59, 14:00-15:59, 16:00-17:59, 18:00-20:00]. These time periods were created to match the ten-examples condition, where a participant received an idea from the confederate every 2 minutes.

### *Quantity*

To analyze how the number of submitted confederate ideas influenced the number of ideas generated by participants, a 4 (condition: one-example, four-examples, ten-examples, twenty-examples) X 10 (time period) ANOVA was calculated on the number of ideas generated. There was no main effect of condition [ $F(3, 76) = 1.15$ ,  $MSE = 12.35$ ]. A main effect of time period was observed [ $F(9, 684) = 35.03$ ,  $MSE = 1.32$ ]. Pairwise comparisons (with a Bonferroni correction) revealed that there were more ideas generated in the first 2 minutes than the other nine time intervals (see Figure 5). There was no difference in the number of ideas in the second, third, fourth, and fifth time periods; however, more ideas were generated in these time periods than all of the

later time periods. Overall, there was a trend that the number of ideas generated decreased as the brainstorming session continued (see Figure 5). The interaction between condition and time period was not significant [ $F(27, 684) = 0.53, MSE = 1.32$ ].

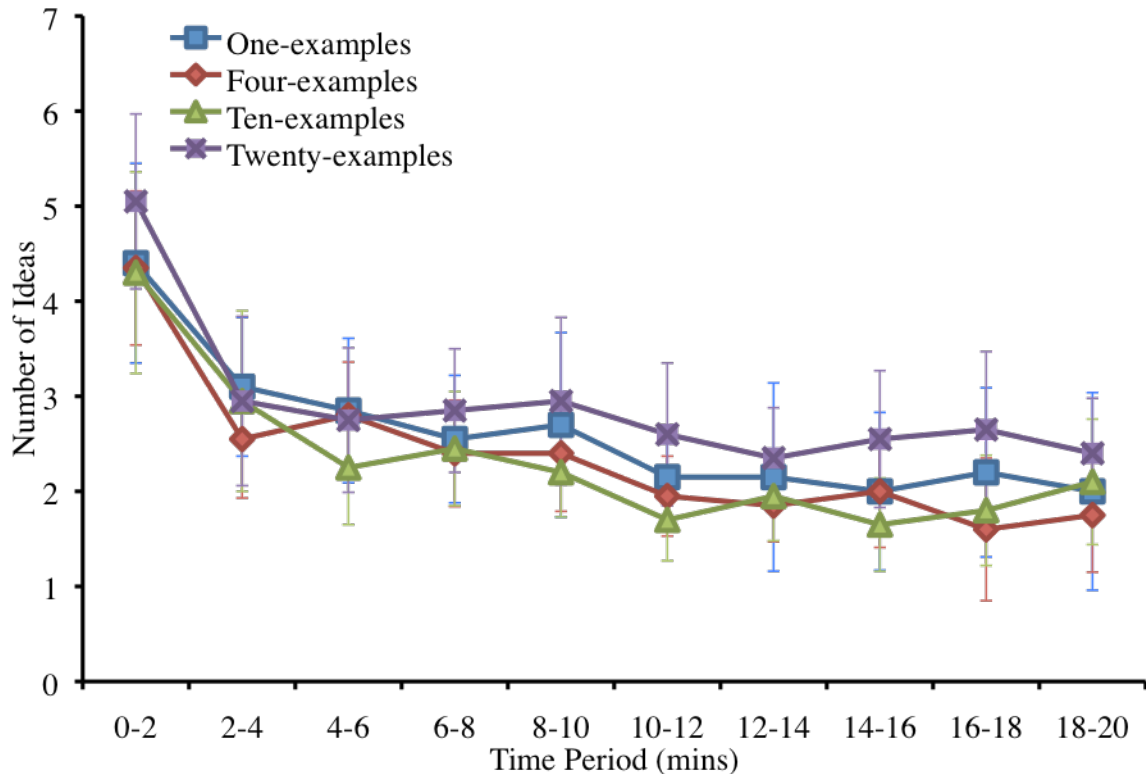


Figure 5. Quantity of ideas generated in Experiment 2.

### *Conformity Analysis*

For each participant, it was calculated the proportion of their ideas that belong to the categories exemplified by the confederate (“conformity”). For example, it was calculated the proportion of the ideas generated by a one-example condition participant that were classified as belonging to the “Transportation” category. A 4 (condition: one-



example, four-examples, ten-examples, twenty-examples) X 10 (time period) ANOVA compared conformity. A main effect of condition was observed [ $F(3, 48) = 100.99$ ,  $MSE = 0.13$ ]. Pairwise tests (with a Bonferroni correction) revealed that participants in the twenty-examples condition and the ten-examples condition had a greater conformity than the four-examples condition, which had a higher conformity than the one-example condition (see Figure 6). There was no main effect of time period [ $F(9, 432) = 1.61$ ,  $MSE = 0.08$ ] or an interaction [ $F(27, 432) = 1.40$ ,  $MSE = 0.08$ ].

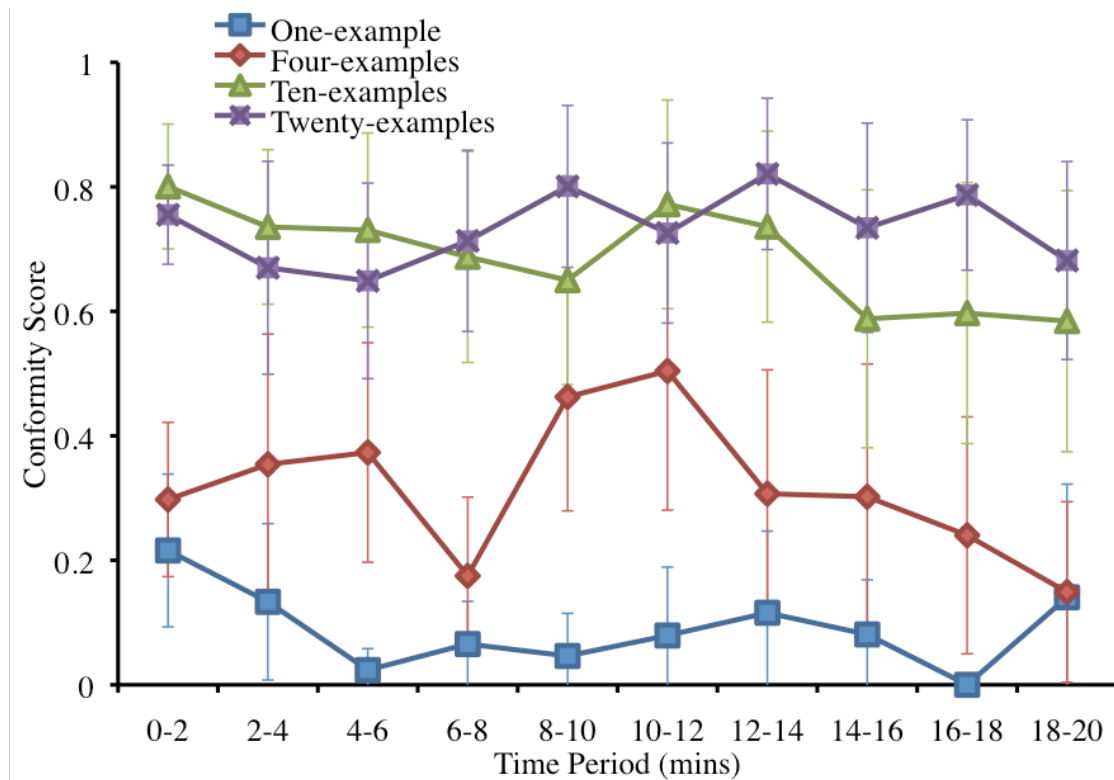


Figure 6. Conformity scores (proportion of ideas belonging to exemplified categories) in Experiment 2.

It could be argued that the significant differences found in the conformity analysis were an artifact of an unfair comparison. As described above, conformity is calculated differently for each condition (dependent upon how many categories are exemplified in that condition). To further investigate if conformity is occurring, a different analysis can take place that looks at only the categories that were not exemplified in *any* of the four conditions. Thus, this would be a more fair comparison. For each participant, it was also calculated the proportion of their ideas that belonged to the 20 categories not exemplified in any of the four conditions (“nonconformity”). These categories had the highest 20 novelty ratings (see Appendix B). A 4 (condition: one-example, four-examples, ten-examples, twenty examples) X 10 (time period) ANOVA compared nonconformity. There was a main effect of condition [ $F(3, 48) = 5.42, MSE = 0.22$ ]. Pairwise tests (with a Bonferroni correction) found that participants in the one-example condition had a higher proportion of the ideas that were not exemplified in Experiment 2 than did the twenty-examples condition and a marginally greater proportion than the ten examples condition ( $p < .10$ ). Overall, there was a trend of greater nonconformity with fewer examples provided (see Figure 7). There was no significant main effect of time period [ $F(9, 432) = 1.27, MSE = 0.10$ ]; however, there was a significant interaction of condition and time period [ $F(27, 432) = 1.59, MSE = 0.10$ ].

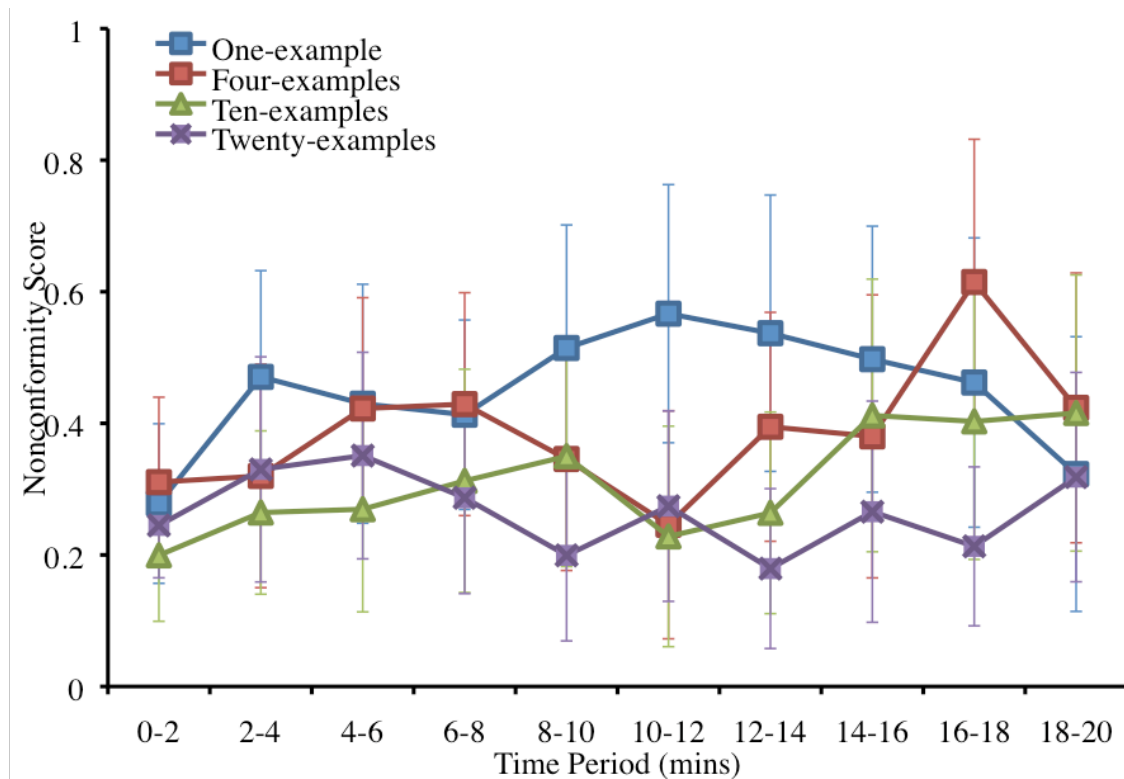


Figure 7. Nonconformity scores (proportion of ideas belonging to the 20 categories not exemplified) in Experiment 2.

### Variety

To analyze how the number of submitted confederate ideas influenced the variety of ideas generated by participants, a 4 (condition: one-example, four-examples, ten-examples, twenty examples) X 10 (time period) ANOVA was calculated on the number of categories explored. There was no effect of condition [ $F(3, 76) = 0.80, MSE = 5.26$ ]. A main effect of time period was observed [ $F(9, 684) = 35.55, MSE = 0.88$ ]. Pairwise comparisons (with a Bonferroni correction) revealed that there were more categories explored in the first 2 minutes than the other nine time intervals (see Figure 6). There was no difference in the number of categories explored in the second, third, fourth, or

fifth time periods; however, more categories were explored in these time periods than all of the later time periods. Overall, there was a trend that the number of categories explored decreased as the brainstorming session continued (see Figure 8). The interaction between condition and time period did not reach significance [ $F(27, 684) = 0.64, MSE = 0.88$ ].

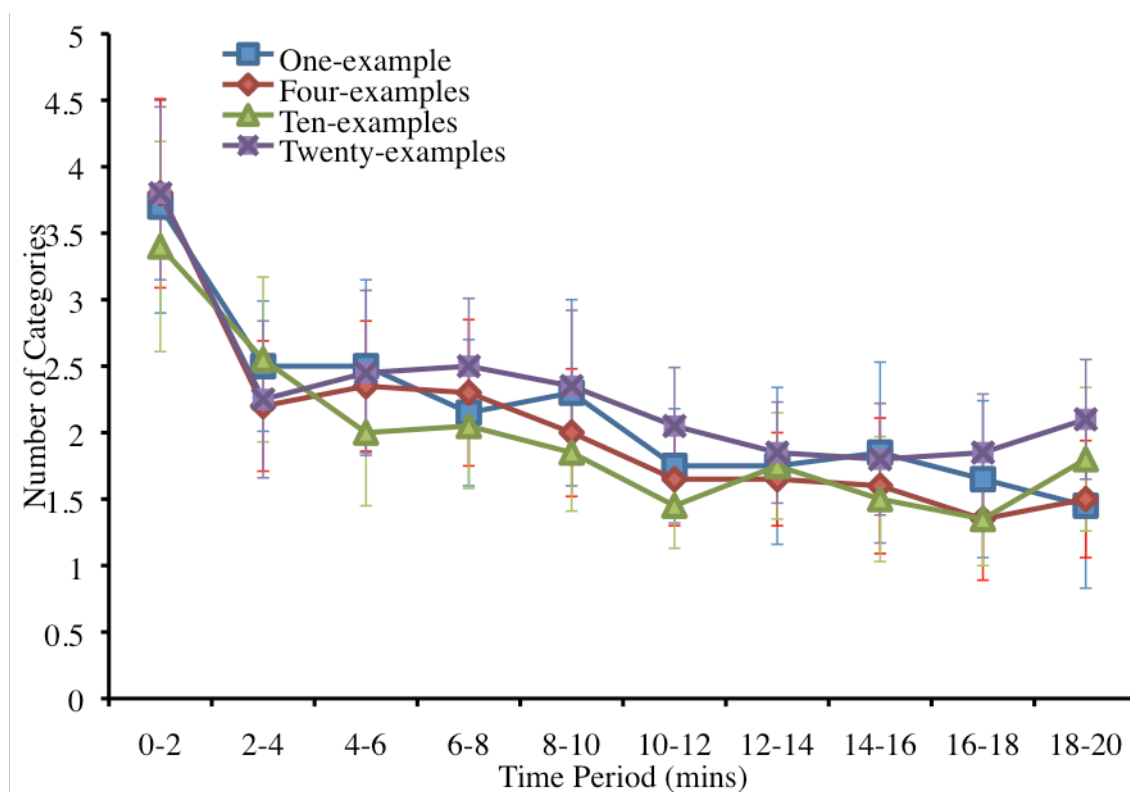


Figure 8. Variety of ideas generated in Experiment 2.

### *Novelty*

To assess the impact of the number of submitted confederate ideas on novelty, a 4 (condition: one-example, four-examples, ten-examples, twenty-examples) X 10 (time

period) ANOVA was calculated on the average novelty of participants' ideas (see Figure 9). There was a main effect of condition [ $F(3, 48) = 7.82, MSE = 3.42$ ]. Pairwise tests (with a Bonferroni correction) found that the ideas generated by participants in the one-example condition ( $M = 2.19, SE = .17$ ) had a higher average novelty score than the ideas generated by participants in the four-examples condition ( $M = 1.38, SE = .16$ ), ten-examples condition ( $M = 1.36, SE = .17$ ) and twenty-examples condition ( $M = 1.14, SE = .15$ ). There was no effect of time period [ $F(9, 432) = 0.53, MSE = 2.34$ ] nor an interaction between the two variables [ $F(27, 432) = 0.96, MSE = 2.34$ ].

To provide an additional indicator of novelty, an analysis was conducted on the highest novelty. This refers to the single idea with the highest novelty score generated during the entire 20-minute session. A 4 (condition: one-example, four-examples, ten-examples, twenty-examples) ANOVA found a main effect of condition on the highest novelty scores [ $F(3, 76) = 4.35, MSE = 72.65$ ]. Pairwise tests (with a Bonferroni correction) revealed that the ideas with the highest novelty score in the one-example condition ( $M = 13.96, SE = 1.91$ ) were greater than the highest novelty scores in the four-examples condition ( $M = 6.26, SE = 1.91$ ), the highest novelty scores in the ten-examples condition ( $M = 6.97, SE = 1.91$ ), and the highest novelty scores in the twenty-examples condition ( $M = 5.20, SE = 1.91$ ). Highest novelty scores were also analyzed in terms of when participants generated their idea with the highest novelty score. A 4(condition: one-example, four-examples, ten-examples, twenty-examples) ANOVA found that there was no main effect of condition on the time during the brainstorming

session in which participants generated their idea with the highest novelty score [ $F(3, 76) = 0.08, MSE = 36.16$ ].

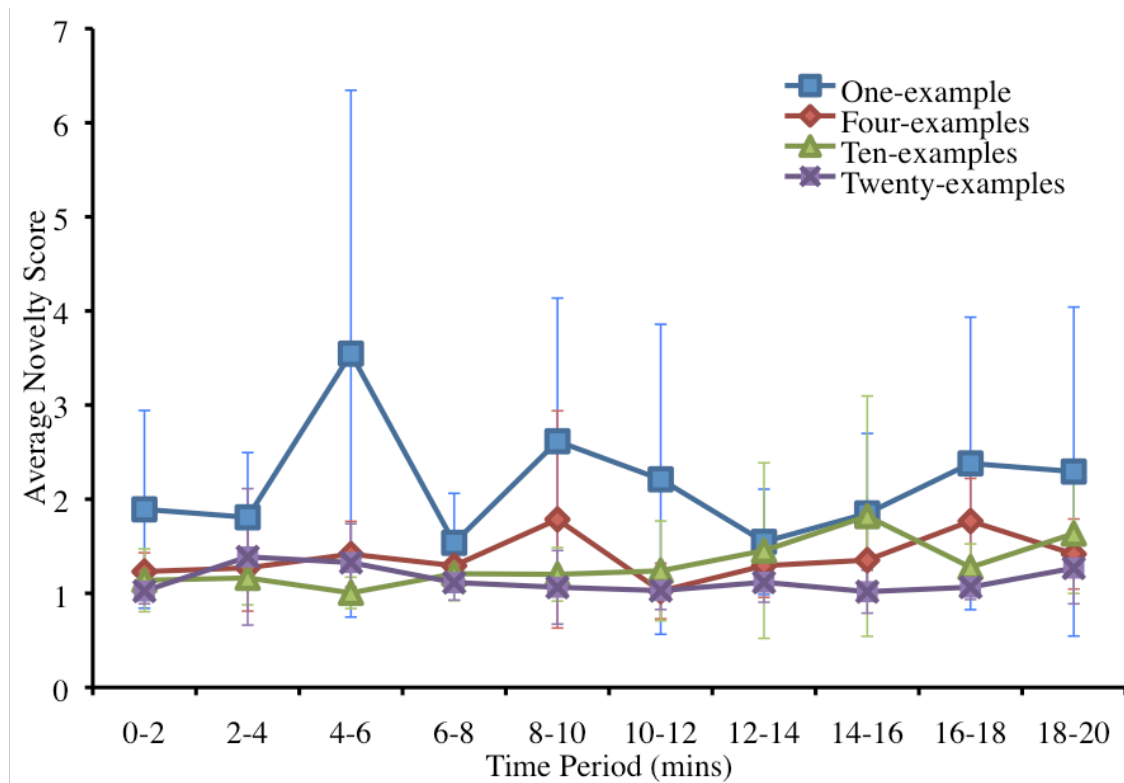


Figure 9. Average novelty of ideas generated in Experiment 2.

## Discussion

Experiment 2 sought to further examine if fixation was occurring in brainstorming groups by controlling the ideas that a participant was exposed to. It was predicted that increasing the amount of exposure to typical ideas would cause the individual to become more fixated on these typical ideas. This in turn would lead to the participant exhibiting more conformity, generating fewer ideas, exploring fewer domains, and reducing the novelty of their ideas.

As predicted, increasing the number of typical ideas a participant was exposed to resulted in an increased amount of conformity. This was indicated by the conformity measure and the nonconformity measure. Participants receiving a higher number of typical ideas not only had a higher proportion of their ideas that belonged to the categories that were exemplified in their condition, but also had a lower proportion of their ideas belonging to the 20 rarest categories. These results are consistent with the present hypothesis and mirrors the results of other studies that have witnessed participants' conformity to provided examples (Chrysikou & Weisberg, 2005; Jansson & Smith, 1991; Smith, Ward, & Schumacher, 1993).

While the amount of conformity increased with the number of examples provided, the quantity and variety analyses did not follow the same pattern. There were no significant differences between the four conditions on either quantity or variety. Thus, these results do not support the hypothesis that fixation contributes to the productivity deficit in terms of quantity of ideas generated. In fact, the number of ideas generated by a participant in Experiment 2 ( $M = 25.55$ ) was nearly the same as the number of ideas generated by a single individual in Experiment 1 ( $M = 26.49$ ). Similarly, the number of categories explored by a participant in Experiment 2 ( $M = 13.02$ ) was nearly identical to the number of categories explored by a single individual in Experiment 1 ( $M = 13.05$ ).

Novelty; however, did fluctuate as a function of the number of provided examples. As the number of typical examples increased, the average novelty of participants' ideas decreased. This was expected and goes hand-in-hand with the

conformity scores. The more a participant stays stuck within typical categories, the less novel the ideas they will generate. The analysis with highest novelty was even more striking. Compared with the twenty-examples condition participants, participants in the one-example condition most novel idea had a novelty score 168% greater. These findings appear to contradict earlier conclusions made regarding the effects of provocative stimuli. Connolly et al. (1993) found that participants who received a common example idea produced more original ideas than participants who received a unique example idea. While example type (typical vs. unique) was not manipulated in the present experiment, based on the findings of Connolly et al., one would predict that receiving *more* typical ideas would have prompted participants to generate more novel ideas. It is possible that the conflicting findings are due to Connolly et al. not providing enough provocation (only one example idea was given to participants).

One of the goals in Experiment 2 was to see if fixation could be experimentally induced in a brainstorming session. If one were to define fixation in terms of participants conforming to others' ideas (in this case, the confederate's ideas), then one could conclude that Experiment 2 was successful in observing fixation in a group brainstorming setting. While fixation did occur, it did not have the predicted result of reducing the number of ideas generated and limiting the domains explored. It appears that participants became stuck within the exemplified categories, generating a high proportion of their ideas within these categories. However, participants still would generate ideas in non-exemplified categories. It is just that as the number of exemplars



increased, participants spent less time generating ideas in these more remote categories and generate a higher proportion of their ideas within the exemplified categories.

In summary, Experiment 2 found that people will conform to others' ideas and will do so the more they are exposed to others' ideas. However, increasing the amount of exposure does not affect the quantity and the variety of their ideas. Thus, Experiment 2 rules out the hypothesis that fixation contributes to the productivity deficit. Now that there is supportive evidence that fixation takes place in group brainstorming settings, the research question now turns to testing whether fixation can be alleviated.

## CHAPTER IV

### EXPERIMENT 3

#### Introduction

The purpose of Experiment 3 was to investigate ways by which to resolve fixation during brainstorming. Incubation intervals have been used to alleviate fixation during creative problem solving and memory retrieval (Browne & Cruse, 1988; Smith & Blankenship, 1989). It is possible that a break during brainstorming will allow an individual or a group to be more productive in generating ideas during the session. A previous study (Paulus, Nakui, Putman, & Brown, 2006) found that incubation intervals increased productivity. However, their results may have been an artifact in that the control and experimental groups were not given equivalent initial ideation time. Experiment 3 corrected this methodological error. The present experiment also tested one of the theories of incubation. The forgetting fixation hypothesis of incubation states that an incubation interval is helpful in that it removes fixation, thus allowing resolution of the problem to occur (Smith & Blankenship, 1991). Thus, it was predicted that incubation intervals would benefit production and alleviate fixation more in situations in which fixation has occurred in the brainstorming session. Experiment 3 manipulated the inducement of fixation as well as the presence of mental breaks during the brainstorming session.

## Method

### *Participants*

Participants for this study originated from an introductory psychology course. For their participation they received credit towards their experimental participation requirement of the course. They had the option of signing up for this experiment as well as numerous others. A total of 91 participants volunteered for this experiment. Eleven participants' data was not included in the analyses due to technical issues or the participant suspecting that a confederate was involved in the experiment. The remaining 80 participants were randomly assigned to one of the four conditions. None of the participants from Experiment 3 participated in the previous two experiments. In addition to actual participants for this study, a confederate was used in this study. The confederate was a Caucasian female undergraduate student who fell in the same age range as the actual participants.

### *Materials*

Three computer terminals with AIM were used for Experiment 3. For the two conditions involving incubation intervals, a packet of six mazes was used as a filler task.

### *Design and Procedure*

For this experiment, participants were divided into one of four conditions: fixating-immediate, fixating-delayed, control-immediate, or control-delayed.

The procedure for Experiment 3 was identical to Experiment 2, with the following exceptions. In the two fixating conditions, participants received a submitted idea from the confederate at the 10-second, 3-minute, 6-minute, and 9-minute mark of

the brainstorming session (for a list of the submitted ideas, see Appendix D).

Participants in the two control conditions did not receive any ideas from the confederate.

In the two immediate conditions, participants generated ideas for 20 minutes without interruption. In the two control conditions, participants were told to stop after 10 minutes. They were then seated at a desk and told that the next task required them to complete as many mazes as possible. This was conducted in a manner to give the participant no indication that they would return to the brainstorming task later. After 5 minutes had elapsed, participants were returned to the computer terminal and asked to continue brainstorming on the same topic. Additionally, they were asked to not submit any previously generated ideas. The second brainstorming session ended after 10 minutes. Just as in Experiment 1, the confederate engaged in typing something (but not submitting) during both 10-minute sessions. Upon conclusion of the subjective report, participants were asked if they were aware that the other participant was a confederate. If they answered “yes,” then their data was not included in the analysis.

## Results

### *Coding*

Every idea generated by participants was classified as belonging to one of the 30 categories used in Experiment 1 (except for vague/uncodable ideas which were not included in the analyses). The ideas generated by participants were analyzed in terms of the first 10 minutes and the last 10 minutes.

### *Analyses of the First 10 Minutes*

The first set of analyses conducted was done in order to assess whether or not the confederate in the two fixating conditions induced fixation. Arguably the largest indicator of fixation would be how many of the ideas generated by participants were similar to the ones submitted by the confederate. Participants in the fixating condition ( $M = .38, SD = .16$ ) had a higher conformity during the first 10 minutes (proportion of their ideas that belonged to the categories exemplified by the confederate) than participants in the control conditions ( $M = .30, SD = .15$ );  $t(78) = 2.48, p = .02$ .

There was no significant difference between the fixating conditions ( $M = 14.50, SD = 7.77$ ) and the control conditions ( $M = 12.50, SD = 5.98$ ) in the number of ideas generated in the first 10 minutes;  $t(78) = 1.29, p = .20$ .

Variety was analyzed by using a 2 (examples: fixating vs. control) X 2 (retest: immediate vs. delayed) ANOVA on the number of categories explored in the first 10 minutes. There was no significant main effect of examples [ $F(1, 76) = 0.21, MSE = 8.39$ ] nor an interaction of examples and retest [ $F(1, 76) = 1.17, MSE = 8.39$ ]. To check that there were no individual differences within the two control conditions and the two fixating conditions, two planned comparisons were conducted. There was no significant difference between the control-immediate ( $M = 7.95, SD = 2.91$ ) and the control-delayed ( $M = 8.55, SD = 3.59$ ) conditions in the number of categories explored in the first 10 minutes;  $t(38) = 0.58, p = .57$ . However, participants in the fixating-delayed condition ( $M = 9.55, SD = 2.56$ ) explored more categories in the first 10 minutes than the fixating-immediate condition ( $M = 7.55, SD = 2.35$ );  $t(38) = 2.56, p = .02$ .

Although numerically greater, the average novelty of ideas generated by participants in the control conditions in the first 10 minutes ( $M = 1.42, SD = 1.27$ ) was not significantly different from the average novelty of ideas generated by participants in the fixating conditions in the first 10 minutes ( $M = 1.08, SD = 0.23$ );  $t(78) = 1.66, p = .11$ . Additionally, the most novel idea generated by participants (highest novelty) in the first 10 minutes was marginally greater in the control conditions ( $M = 5.34, SD = 8.96$ ) than by participants in the fixating conditions ( $M = 2.69, SD = 1.61$ );  $t(78) = 1.85, p = .07$ .

#### *Analyses of the Last 10 Minutes*

To assess if the addition of an incubation interval results in an increase in the quantity of ideas generated by participants, a 2 (examples: fixating vs. control) X 2 (retest: immediate vs. delayed) ANOVA was calculated on the number of ideas generated in the last 10 minutes. There was a main effect of retest [ $F(1, 76) = 5.71, MSE = 35.33$ ]; more ideas were generated in the delay conditions ( $M = 11.23, SE = .94$ ) than in immediate conditions ( $M = 8.05, SE = .94$ ), a 40% increase. No significant main effect of examples was observed [ $F(1, 76) = 2.32, MSE = 35.33$ ]; however, there was a significant interaction of examples and retest [ $F(1, 76) = 5.89, MSE = 35.33$ ]. Planned comparisons found that more ideas were generated in the fixating-delayed condition ( $M = 13.85, SD = 7.98$ ) than in the fixating-immediate condition ( $M = 7.45, SD = 4.63$ ), an 86% increase;  $t(38) = 3.10, p = .00$ . There was no difference between the control-delayed condition ( $M = 8.60, SD = 5.35$ ) and the control-immediate conditions ( $M = 8.65, SD = 5.25$ );  $t(38) = 0.03, p = .98$ .

To assess if the addition of an incubation interval results in an increase the variety of ideas, the number of categories explored in the last 10 minutes was analyzed. Given the unexpected result that there was a difference in the variety for the two fixating conditions in the first 10 minutes, an ANCOVA was calculated. A 2 (examples: fixating vs. control) X 2 (retest: immediate vs. delayed) ANCOVA was calculated on the number of categories explored in the last 10 minutes with the number of categories explored in the first 10 minutes used as the covariate. There was no main effect of examples [ $F(1, 75) = 0.06, MSE = 6.07$ ] nor a main effect of retest [ $F(1, 75) = 0.58, MSE = 6.07$ ]. A significant interaction of examples and retest was observed [ $F(1, 75) = 4.45, MSE = 6.07$ ]. Planned comparisons found that more categories were explored in the fixating-delayed condition ( $M = 8.00, SD = 3.43$ ) than in the fixating-immediate condition ( $M = 5.10, SD = 2.51$ ), a 57% increase;  $t(38) = 3.05, p = .00$ . There was no difference between the control-delayed condition ( $M = 6.05, SD = 3.52$ ) and the control-immediate conditions ( $M = 6.40, SD = 2.76$ );  $t(38) = 0.35, p = .73$ .

To assess if the addition of an incubation interval results in an increase in the novelty of ideas, a 2 (examples: fixating vs. control) X 2 (retest: immediate vs. delayed) ANOVA was calculated on the average novelty in the last 10 minutes. There was no main effect of retest [ $F(1, 75) = 0.19, MSE = 1.56$ ] or of examples [ $F(1, 75) = 0.34, MSE = 1.56$ ]. Additionally, there was no significant interaction of examples and retest [ $F(1, 75) = 0.01, MSE = 1.56$ ]. Highest novelty in the last 10 minutes was also analyzed using a 2 (examples: fixating vs. control) X 2 (retest: immediate vs. delayed) ANOVA. There was no main effect of retest [ $F(1, 75) = 0.37, MSE = 60.56$ ] or of examples [ $F(1, 75) =$

0.16,  $MSE = 60.56$ ]. Additionally, there was no significant interaction of examples and retest [ $F(1, 75) = 0.77, MSE = 60.56$ ].

To assess if the addition of an incubation interval results in a decrease in the amount of conformity, a 2 (examples: fixating vs. control) X 2 (retest: immediate vs. delayed) ANOVA was calculated on the conformity in the last 10 minutes. There was no main effect of retest [ $F(1, 75) = 0.90, MSE = 0.04$ ] or of examples [ $F(1, 75) = 0.83, MSE = 0.04$ ]. Additionally, there was no significant interaction of examples and retest [ $F(1, 75) = 1.99, MSE = 0.04$ ].

To assess if the addition of an incubation interval results in new categories being explored, reminiscence was analyzed. Reminiscence was calculated by dividing the number of categories explored in the last 10 minutes that were not explored in the first 10 minutes by the number of possible new categories to be explored. For example, if a participant explored 10 categories in the first 10 minutes (leaving 20 categories not explored) and explores 5 new categories in the last 10 minutes, then reminiscence would equal 0.25. A 2 (examples: fixating vs. control) X 2 (retest: immediate vs. delayed) ANOVA was calculated on reminiscence. There was no main effect of retest [ $F(1, 76) = 0.69, MSE = 0.01$ ] or of examples [ $F(1, 76) = 1.39, MSE = 0.01$ ]. Additionally, there was no significant interaction of examples and retest [ $F(1,76) = 0.63, MSE = 0.01$ ].

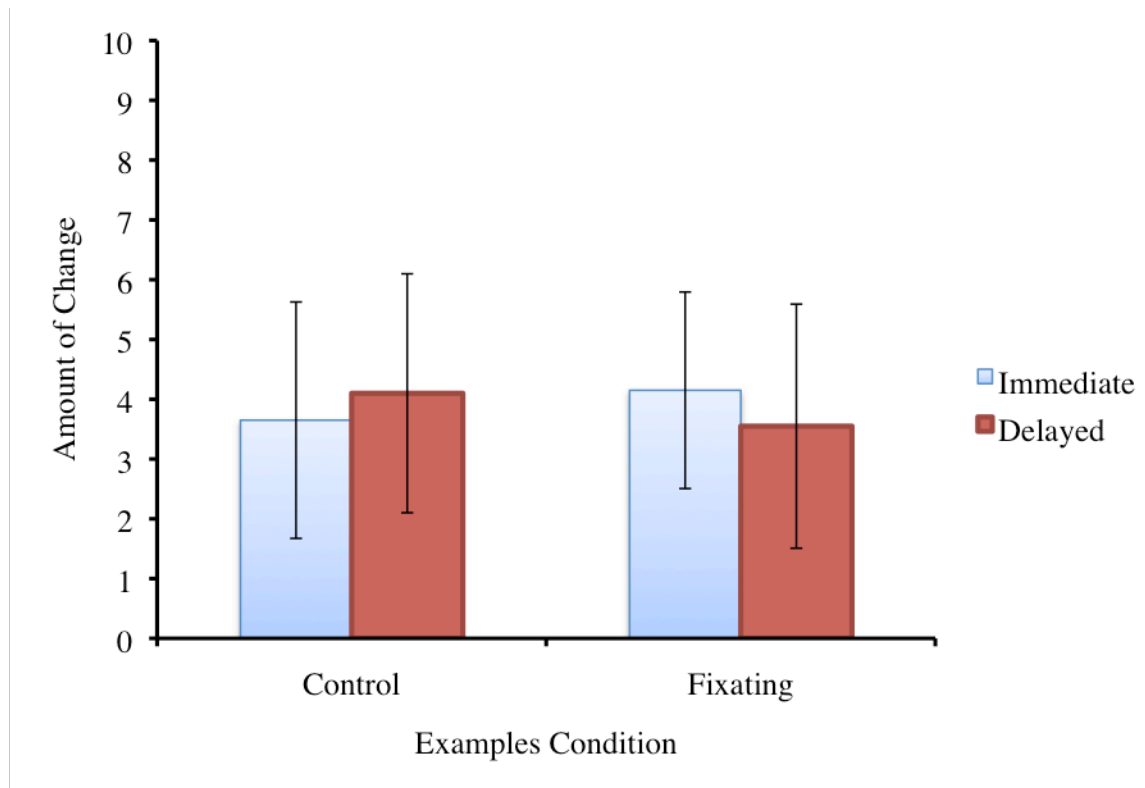
#### *Measure of Incubation Effects*

To further assess if the incubation periods were effective in aiding brainstorming, five dependent measures were analyzed: quantity-change, variety-change, average novelty-change, highest novelty-change, and conformity-change.



Quantity-change was calculated by subtracting the number of ideas generated in the last 10 minutes from the number of ideas generated in the first 10 minutes. A 2(examples: fixating vs. control) X 2(retest: immediate vs. delayed) ANOVA analyzed quantity-change. There was no main effect of examples [ $F(1, 76) = 0.01, MSE = 16.74$ ], retest [ $F(1, 76) = 0.01, MSE = 16.74$ ], or an interaction of the two variables [ $F(1, 76) = 0.33, MSE = 16.74$ ]. Two planned comparisons were also conducted. In the control conditions, there was a greater (but non-significant) quantity-change in the delayed condition than in the immediate condition (see Figure 10);  $t(38) = 0.34, p = .74$ . Conversely, in the fixating conditions, there was a greater (but non-significant) quantity-change in the immediate condition than in the delayed condition;  $t(38) = 0.48, p = .63$ .

Variety-change was similarly calculated by subtracting the number of categories explored in the last 10 minutes from the number of categories explored in the first 10 minutes. A 2(examples: fixating vs. control) X 2(retest: immediate vs. delayed) ANOVA analyzed variety-change. There was no main effect of examples [ $F(1, 76) = 0.01, MSE = 7.02$ ], retest [ $F(1, 76) = 0.01, MSE = 7.02$ ], or an interaction of the two variables [ $F(1, 76) = 2.44, MSE = 7.02$ ]. Two planned comparisons were also conducted. In the control conditions, there was a greater (but non-significant) variety-change in the delayed condition than in the immediate condition (see Figure 11);  $t(38) = 1.06, p = .30$ . Conversely, in the fixating conditions, there was a greater (but non-significant) variety-change in the immediate condition than in the delayed condition;  $t(38) = 1.16, p = .25$ .



*Figure 10.* Amount of quantity-change (first 10 minutes – last 10 minutes) by condition in Experiment 3.

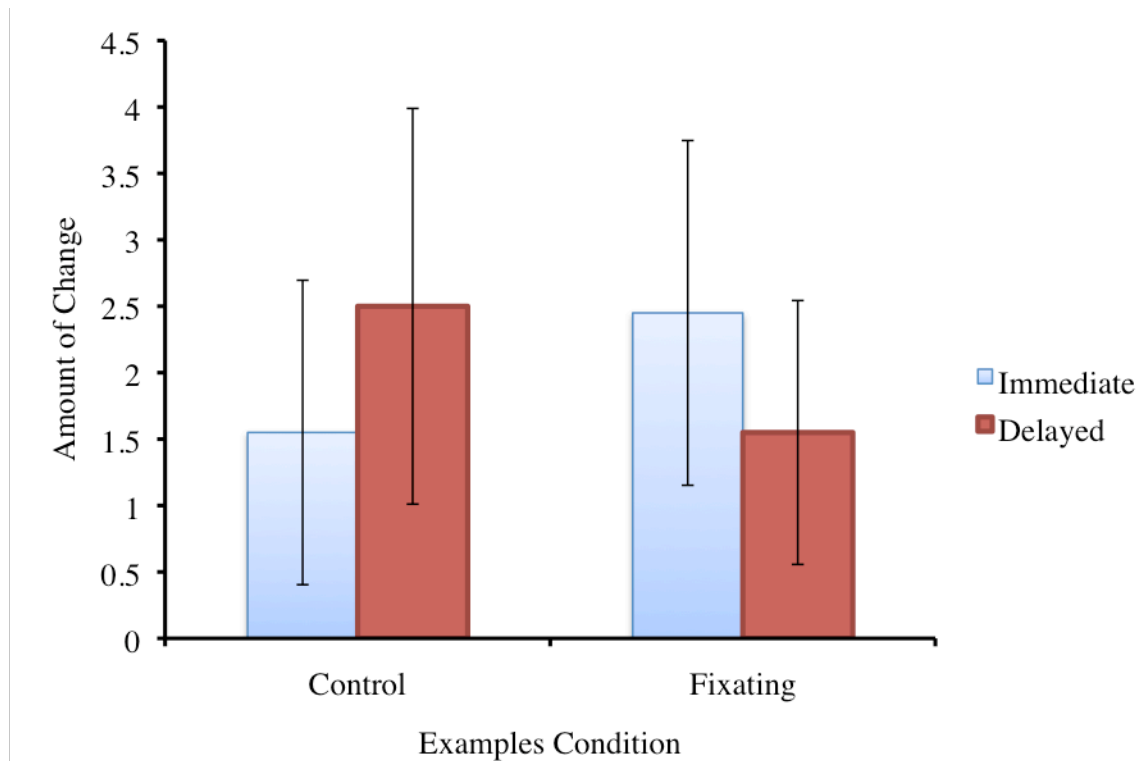
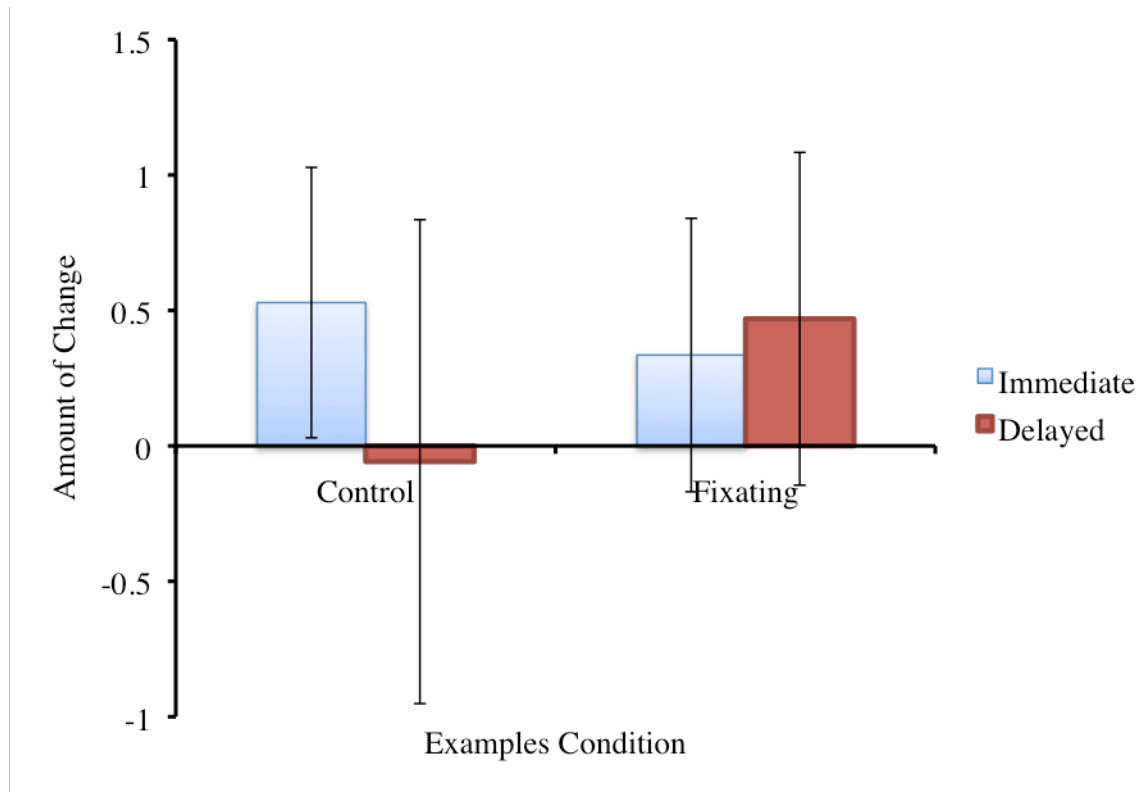


Figure 11. Amount of variety-change (first 10 minutes – last 10 minutes) by condition in Experiment 3.

Average novelty-change was calculated by subtracting the average novelty score in the first 10 minutes from the average novelty score in the last 10 minutes. A 2(examples: fixating vs. control) X 2(retest: immediate vs. delayed) ANOVA analyzed average novelty-change. There was no main effect of examples [ $F(1, 75) = 0.29, MSE = 1.90$ ], retest [ $F(1, 75) = 0.54, MSE = 1.90$ ], or an interaction of the two variables [ $F(1, 75) = 1.35, MSE = 1.90$ ]. Two planned comparisons were also conducted. In the control conditions, the average novelty increased more (but non-significantly) in the last 10 minutes in the immediate condition (see Figure 12) than in the delayed condition (which

actually decreased);  $t(38) = 1.21, p = .24$ . Conversely, in the fixating conditions, there was a greater increase (but not-significant) in average novelty in the delayed condition than in the immediate condition;  $t(37) = 0.35, p = .73$ .

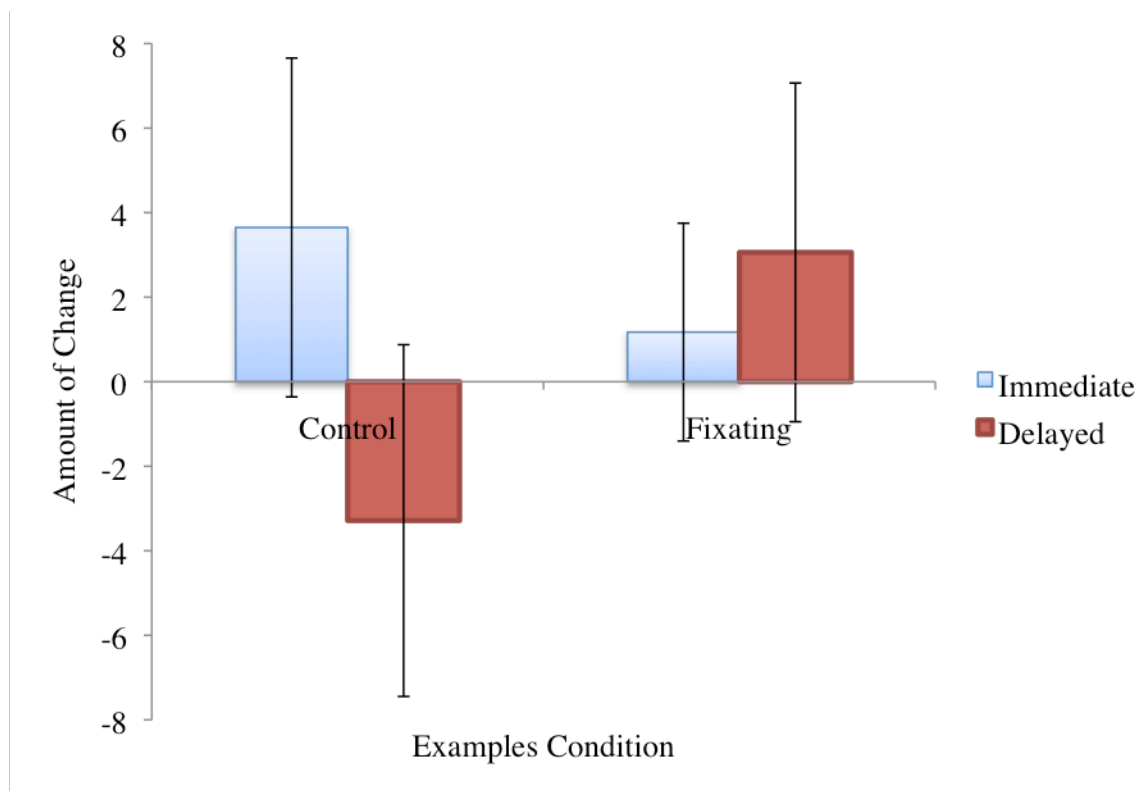


*Figure 12.* Amount of average novelty-change (last 10 minutes – first 10 minutes) by condition in Experiment 3. Positive values indicate an increase in average novelty during the last 10 minutes.

Highest novelty-change was calculated by subtracting the highest novelty score in the first 10 minutes from the highest novelty score in the last 10 minutes. A 2(examples: fixating vs. control) X 2(retest: immediate vs. delayed) ANOVA analyzed

highest novelty-change. There was no main effect of examples [ $F(1, 75) = 1.16, MSE = 63.55$ ] or retest [ $F(1, 75) = 1.98, MSE = 63.55$ ]; however there was a significant interaction of the two variables [ $F(1, 75) = 6.04, MSE = 63.55$ ]. Two planned comparisons were also conducted. In the control conditions, the highest novelty significantly increased more in the last 10 minutes in the immediate condition (see Figure 13) than in the delayed condition (which actually decreased);  $t(38) = 2.52, p = .02$ . Conversely, in the fixating conditions, there was a greater increase (but not-significant) in the highest novelty in the delayed condition than in the immediate condition;  $t(37) = 0.82, p = .42$ .

Conformity-change was calculated by subtracting the conformity score in the last 10 minutes from the conformity in the first 10 minutes. A 2(examples: fixating vs. control) X 2(retest: immediate vs. delayed) ANOVA analyzed conformity-change. There was no main effect of examples [ $F(1, 75) = 0.69, MSE = 0.06$ ], retest [ $F(1, 75) = 0.09, MSE = 0.06$ ], or an interaction of the two variables [ $F(1, 75) = 1.45, MSE = 0.06$ ]. Two planned comparisons were also conducted. In the control conditions, conformity increased in the delayed condition ( $M = -.04, SD = .22$ ) and decreased in the immediate condition ( $M = .04, SD = .18$ ); however, this difference was not significant (see Figure 14);  $t(38) = 1.28, p = .21$ . Conversely, in the fixating conditions, there was a greater decrease in the amount of conformity in the delayed condition ( $M = .07, SD = .20$ ) than in the immediate condition ( $M = .02, SD = .33$ ); however, this difference did not approach significance;  $t(37) = 0.57, p = .57$ .



*Figure 13.* Amount of highest novelty-change (last 10 minutes – first 10 minutes) by condition in Experiment 3. Positive values indicate an increase in highest novelty during the last 10 minutes.

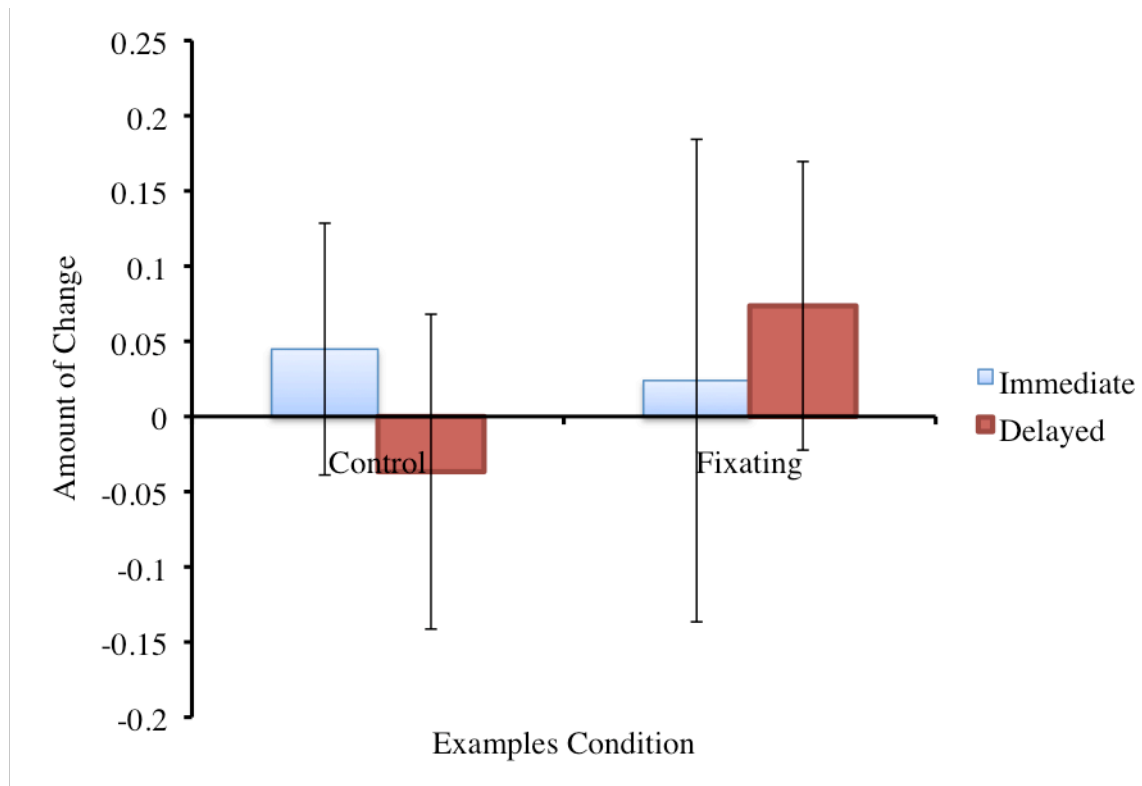


Figure 14. Amount of conformity-change (last 10 minutes – first 10 minutes) by condition in Experiment 3. Positive values indicate a reduction in conformity during the last 10 minutes.

#### *Analyses of the Entire Brainstorming Session*

To further examine the influence of the confederate's submissions on the ideas generated by participants, an additional set of analyses were conducted. A 2 (examples: fixating vs. control) X 2 (retest: immediate vs. delayed) ANOVA compared the total number of ideas generated by participants during the entire brainstorming session. There was a main effect of retest [ $F(1, 76) = 5.48, MSE = 143.60$ ]; more ideas were generated in the delay conditions ( $M = 26.28, SE = 1.90$ ) than in the immediate conditions ( $M =$

20.00,  $SE = 1.90$ . No significant main effect of examples was observed [ $F(1, 76) = 2.26$ ,  $MSE = 143.60$ ]; however, there was a significant interaction of examples and retest [ $F(1, 76) = 4.89$ ,  $MSE = 143.60$ ]. A follow-up t-test found that there were more ideas generated in the fixating-delay condition ( $M = 31.25$ ,  $SD = 15.67$ ) than in the fixating-immediate condition ( $M = 19.05$ ,  $SD = 10.29$ );  $t(38) = 2.91$ ,  $p = .01$ . There was no difference in the number of ideas generated by the control-delayed condition ( $M = 21.30$ ,  $SD = 10.96$ ) and the control-immediate condition ( $M = 20.95$ ,  $SD = 10.15$ );  $t(38) = 0.11$ ,  $p = .92$ .

To assess variety, a 2 (examples: control vs. fixating) X 2 (retest: immediate vs. delayed) ANOVA compared the number of categories explored during the entire 20 minutes. There was no significant main effect of examples [ $F(1, 76) = 0.27$ ,  $MSE = 28.80$ ]. A main effect of retest was observed [ $F(1, 76) = 4.60$ ,  $MSE = 28.80$ ] with delayed conditions ( $M = 16.08$ ,  $SE = .85$ ) exploring more categories than immediate conditions ( $M = 13.50$ ,  $SE = .85$ ). The interaction between examples and retest was marginally significant [ $F(1, 76) = 3.75$ ,  $MSE = 28.80$ ,  $p = .06$ ]. Follow-up t-tests found that there was no difference between the control-immediate ( $M = 14.35$ ,  $SD = 4.71$ ) and the control-delayed conditions ( $M = 14.60$ ,  $SD = 6.68$ );  $t(38) = 0.14$ ,  $p = .89$ . Participants in the fixating-delayed condition ( $M = 17.55$ ,  $SD = 5.41$ ) had a greater variety of ideas than did participants in the fixating-immediate condition ( $M = 12.65$ ,  $SD = 4.38$ );  $t(38) = 3.15$ ,  $p = .00$ .

To assess novelty, a 2 (examples: control vs. fixating) X 2 (retest: immediate vs. delayed) ANOVA was calculated on the average novelty of ideas generated during the



entire 20 minutes. Although numerically greater, there was no significant difference between the control ( $M = 1.57, SE = .15$ ) and the fixating ( $M = 1.25, SE = .15$ ) conditions [ $F(1, 76) = 2.24, MSE = .87$ ]. Similarly, the numerical difference between the delayed ( $M = 1.53, SE = .15$ ) and immediate ( $M = 1.28, SE = .15$ ) conditions was not significant [ $F(1, 76) = 1.43, MSE = .87$ ]. There was no significant interaction [ $F(1, 76) = 0.88, MSE = .87$ ].

A 2 (examples: control vs. fixating) X 2 (retest: immediate vs. delayed) ANOVA was also calculated on the highest novelty during the entire 20 minutes. Although numerically greater, there was no significant difference between the control ( $M = 7.43, SE = 1.33$ ) and the fixating ( $M = 4.71, SE = 1.33$ ) conditions [ $F(1, 76) = 2.09, MSE = 70.97$ ]. Similarly, the numerical difference between the delayed ( $M = 7.18, SE = 1.33$ ) and immediate ( $M = 4.96, SE = 1.33$ ) conditions was not significant [ $F(1, 76) = 1.39, MSE = 70.97$ ]. There was no significant interaction [ $F(1, 76) = 0.88, MSE = 70.97$ ].

To assess conformity, a 2 (examples: control vs. fixating) X 2 (retest: immediate vs. delayed) ANOVA was calculated on the amount of conformity during the entire 20 minutes. There was a significant main effect of examples [ $F(1, 76) = 5.47, MSE = .02$ ]; fixating conditions ( $M = .36, SE = .02$ ) exhibited more conformity than did control conditions ( $M = .29, SE = .02$ ). There was no significant effect of retest [ $F(1, 76) = 2.36, MSE = .02$ ] and there was no significant interaction of examples and retest [ $F(1, 76) = 0.79, MSE = .02$ ].

## Discussion

The purpose of Experiment 3 was to further investigate fixation effects in brainstorming and assess the impact of incubation intervals on brainstorming. It was predicted that incubation intervals would be effective in positively influencing brainstorming only in the case where fixation was induced.

As evidenced by the conformity analysis for the first 10 minutes of the sessions, fixation appears to have been induced. Participants in the fixating conditions had a higher proportion of their ideas belong to the exemplified categories. Experiment 2 was able to demonstrate that fixation fluctuated with the amount of typical ideas received; however, there was no comparison condition in which participants received no ideas from a confederate. In Experiment 3, a clear fixation effect was observed when comparing the fixating conditions to the control conditions.

Like Experiment 2, exposure to others' ideas did not influence the number of ideas generated in Experiment 3. There was no difference between the control and fixating conditions in the first 10 minutes. Similarly, exposure did not cause a change in the number of categories explored. This result also mirrored the findings in Experiment 2. These findings, along with the conformity analysis, support the conclusion established in Experiment 2 that exposure to others' ideas does not reduce the number of categories that they explore. Rather, exposure induces a person to spend more time/resources generating ideas in the categories that are exemplified.

As predicted, incubation intervals influenced brainstorming in the fixating conditions differently than in the control conditions. As found in the three experiments,

naturally with time the number of ideas generated decreases, the variety decreases, and the novelty of ideas increases. In the last 10 minutes of brainstorming in Experiment 3, there were more ideas generated and more categories explored in the fixating-delayed condition than in the fixating-immediate condition. There was no difference between the two control conditions on these two dependent measures. This coupled with the change analyses paints a rather striking picture. If a person becomes fixated in a brainstorming session, the presence of an incubation period has the effects of reducing the natural drop-off in quantity and variety. This finding supports the suggestion that the benefits of exposure to others' ideas in a group setting might not be evident until a later individual session (Dugosh et al., 2000; Osborn, 1963). However, the present research indicates that this benefit only occurs if a break takes place. In addition to aiding the number of ideas generated, taking a break further reduces the amount of conformity and also increases the novelty of later ideas. These four trends are in the opposite direction if a person is not fixated. In the control conditions, an incubation period had the effects of increasing the quantity and variety drop-off, reducing the novelty of later ideas, and increasing the amount of conformity. Together, these results lend support for the forgetting fixation of incubation that predicts incubation effects will only be found when a person has become initially fixated (Smith & Blankenship, 1989, 1991).

On the surface it would appear that the reminiscence analysis and the analysis of variety in the last 10 minutes conflict with one another. How could the fixating-delayed condition explore more categories than the fixating-immediate condition, yet have no significant difference between the two conditions in the number of new categories

explored? What appears to have happened is that the incubation interval did not cause participants to tap new previously unexplored categories, but rather it allowed them to keep generating ideas in a wide variety of categories. Participants in the fixating-immediate condition did not have the benefit of receiving a break and had a much sharper drop-off in the number of categories explored (see Figure 7).

While the trends in the fixating conditions were in the opposite direction than the control conditions with regards to incubation effects, it is worth revisiting that there were no significant differences in the comparisons performed (see Figures 7, 8, 9, 10, 11). The forgetting fixation hypothesis states that incubation effects occur due a change in mental set that allows a person to no longer be fixated. This can take place with a prolonged break or a dramatic shift in context. It is very possible that the 5 minute break of completing mazes was not enough time to change the context, especially since the brainstorming and the interpolated task took place in the same room. Had the incubation interval been longer and/or the interpolated task been more demanding, the incubation effects would likely have been stronger.

The present experiment is not the first experiment to look at how breaks influence brainstorming. Paulus et al. (2006) found that taking a break increased the number of ideas generated. However, as mentioned earlier, it is possible that their result was an artifact of break and no-break conditions having a different amount of time for initial idea generation. The present experiment offers a more fair comparison, but does support Paulus et al.'s (2006) finding that a break does allow a participant to generate more ideas following the break.

In summary, Experiment 3 again found that fixation, as measured by conformity, occurs when a person is presented with ideas from another individual. An incubation interval is only effective (in terms of quantity, variety, novelty, and conformity) if the person was initially fixated. However, given that the vast majority of brainstorming is conducted by having two or more people exchanging ideas, the results from Experiment 3 would suggest that incubation intervals are a beneficial addition to brainstorming sessions.

## CHAPTER V

### GENERAL DISCUSSION AND CONCLUSIONS

This dissertation reviewed the literature on brainstorming and on fixation. From this, it was hypothesized that fixation takes place in brainstorming and that the presence of fixation in a brainstorming group can lead to the productivity deficit. Three experiments were conducted to test this hypothesis with the goals of: observing the differences between individual and group brainstorming sessions; examining if fixation can be induced through the exchanging of ideas; and testing if fixation in brainstorming can be alleviated through incubation. It was predicted that a productivity deficit would be observed, just as it has been found in numerous previous studies (e.g., Diehl & Stroebe, 1987, 1991; Gallupe et al., 1991; Mullen et al., 1991). More importantly, it was predicted that the exchanging of ideas would induce fixation. This would take place in the form of real groups limiting the domains of ideas generated as well as participants conforming their ideas to the ideas they were exposed to. Lastly, it was predicted that to some extent, fixation could be removed by giving participants a break from the idea generating session (incubation).

#### Fixation Taking Place in Brainstorming

Based on the cumulative results from the three present experiments, one can say that fixation takes place in brainstorming. Experiment 3 used a control comparison and found that participants exposed to another person's ideas (fixating conditions) are more likely to conform to the other person's ideas than participants who did not receive any exposure (control conditions). In Experiment 2, it was found that not only do people

conform to ideas they are exposed to; but that the rate of conformity increases as the number of ideas they are exposed to increases. In Experiment 1, measures of brainstorming were analyzed in terms of group type (nominal versus real). Real groups explored fewer categories of ideas than did nominal groups. While conformity was not measured in Experiment 1, it does appear that the exchanging of ideas that took place in real groups led to group members conforming to one another and thus limiting the domains that they explored. The sharing of ideas also had another effect on idea generation. Increasing the amount of exposure to typical ideas caused participants to generate less novel ideas. This finding is in conjunction with the conformity results. If a participant conforms to typical ideas, then this will in turn lower the average novelty of their own ideas. However, the results show that it went beyond just lowering their average novelty score. As indicated by the highest novelty analysis, receiving numerous typical ideas from their partner had the effect of dramatically hindering their ability to generate a highly novel idea.

#### Productivity Deficit

As mentioned, one of the goals of this dissertation was to further examine the productivity deficit and assess if fixation is a contributing factor to the deficit. Experiment 1, like numerous other studies (Diehl & Stroebe, 1987, 1991; Gallupe et al., 1991; Mullen et al., 1991) observed a productivity deficit. Nominal groups generated more non-redundant ideas than did real groups. This is important because it shows that the use of AIM as an EBS medium results in similar findings as those observed in

previous studies (e.g., Gallupe et al., 1991) and that the mental processes captured in the present study are comparable to previous studies.

The majority of the literature on the productivity deficit has focused on the total quantity of ideas generated by real and nominal groups. In the present study, productivity was examined on a temporal scale. From this, the productivity deficit becomes clearer. The disparity in the number of ideas generated between the real and nominal groups is greatest in the beginning of the experiment. Nominal groups still outperform real groups throughout the course of the brainstorming session; however, the difference decreases with time. At the conclusion of Experiment 1, it was believed that fixation was partially responsible for the productivity deficit. In an attempt to gain evidence if this was occurring, Experiment 2 was conducted with the aim to control the ideas a participant is exposed to. Experiment found that fixation, as measured by conformity, increased with the amount of exposure. However, this trend was not found with the number of ideas generated. Thus, it does not appear that fixation is a contributing factor in the productivity deficit. It is possible that exposure from multiple partners (three, instead of only one) could lead to a decrease in the number of ideas generated. If that were found to be true, then this would mean that the number of ideas one is exposed to is not as strong of a determinant of a deficit as is the number of people in the brainstorming group.

#### Temporal Findings

Not only did Experiment 1 provide a close inspection of the productivity deficit, but it also revealed other interesting temporal effects. For individuals as well as groups,



there is a natural decline in the number of ideas generated over time. As mentioned, this decline occurs at a different rate for nominal and real groups. Variety has a pattern similar to quantity. Over time, there is a natural decline in the number of categories explored by individuals as well as groups. However, unlike quantity, the decline occurs at roughly the same rate for nominal and real groups. Novelty fluctuates with time differently than quantity and variety. The results from Experiment 1 and from the fixating conditions in Experiment 3 suggests that over time, the novelty of generated ideas increases slightly. However, given the conflicting results from Experiment 2, further exploration is needed to fully understand how novelty changes during the course of a brainstorming session.

#### Incubation Effects

Experiment 3 sought to alleviate fixation in brainstorming through the means of incubation. As predicted, incubation effects were modulated by whether or not participants were exposed to another person's ideas. In real world settings, members of a brainstorming group are interacting with one another and exchanging ideas. Therefore, the observed beneficial effects of an incubation interval have great external validity. These effects include reducing the natural decline in quantity and variety. So as to keep a group generating numerous ideas and a wide range of ideas, it appears that a break in the session would be beneficial. Furthermore, a break appears to enhance the natural rise in novelty. Although minimal, an incubation period did appear to reduce the amount of conformity of ideas once a person had become fixated upon ideas they were earlier exposed to.

## Limitations

While the present study revealed several new findings, there are some limitations of the results. Experiments 2 and 3 found that exposing participants to ideas led to the participants conforming their ideas to the ones they viewed. These two experiments used a paradigm of one participant and one confederate. So, the experiments used brainstorming groups of two people, whereas in the majority of previous experiments, groups of four people were studied. Furthermore, it would seem likely that most organizations engage in brainstorming sessions of more than two people. It is not known how conformity levels would vary with increasing the group size. The present study is a step in the right direction. By using a highly controlled setting, fixation was observed in pairs. The next step would be to study fixation in larger groups.

As discussed earlier, there are limitations with the findings from Experiment 3. Given the stark contrast in the pattern of the data between the control conditions and the fixating conditions, it seems clear that the presence of an incubation interval in a brainstorming sessions is only beneficial if the exchange of information is taking place. However, to achieve absolute certainty, further investigation is needed. Additionally, it is not known how the presence of larger groups would modulate incubation effects. It is predicted that given an adequate incubation interval, individuals and groups would benefit from the break, as evidenced by a decreased drop-off in quantity and variety as well as a reduction in any conformity to previously submitted ideas.

Another limitation of the present study is that the ideas presented to participants originated from the most typical categories of ideas for the brainstorming topic. In these

experiments, participants conformed to these ideas at a relatively high rate. One of the consequences of this was that this lowered the novelty of their own ideas. It is not known if participants would exhibit the same levels of conformity if they were stimulated with only highly novel ideas or if they were stimulated with a mixture of novel and typical ideas. How typical or novel the ideas a group member(s) is exposed to in a real-world setting would depend upon numerous factors (e.g., topic, time, group's familiarity with the task, etc.). So, it is important to study how conformity is influenced by the type of ideas shared (typical or novel).

#### Theoretical Implications of Findings

Fixation is a cognitive event that takes place in numerous settings. It occurs when people attempt to retrieve a memory, use an object in a non-typical function, create new category members, and engage in creative problem solving. Social conformity is also quite prevalent, with judgments, production matching, and design to name a few. The present study has found yet another context in which people can become fixated and inadvertently conform. No prior studies have investigated if fixation/conformity takes place in brainstorming. The results of the present study are in line with the existing literature on fixation and conformity.

One of the proposed benefits of brainstorming is that it will allow for mutual stimulation. The concept is that hearing each other's ideas will allow the group members to explore new categories that might have otherwise been not explored. Furthermore, "piggybacking" might occur where one group member builds their ideas off of another group member's idea. The results from the present study offers mixed

findings in regards to these predictions. Experiment 2 showed that piggybacking did appear to be taking place as participants were generating a large proportion of their ideas in the same categories as those exemplified by the confederate. However, Experiment 1 contradicts the prediction that mutual stimulation leads to more domain exploration. Participants did just the opposite; interacting real groups explored fewer categories than did non-interacting nominal groups.

The forgetting fixation theory of incubation states that incubation effects are due to an individual resolving some type of fixation (e.g., mental block) through a change in context, provided by the incubation interval. Thus, the theory predicts that incubation effects will only be present in situations in which the individual has become fixated. Supportive findings have been found for this theory using experiments in which individuals solve insight problems (e.g., Smith & Blankenship, 1991) or engage in memory retrieval (Smith & Vela, 1991). The present study lends some support for forgetting fixation theory because an incubation period was only beneficial in the case where participants were initially fixated.

One of the driving hypotheses of this study was that fixation can partially account for the productivity deficit. Experiment 1 supported this hypothesis in that there was a decreased amount of variety where there was a productivity deficit. However, upon further attempts to explore this, it was found that inducing fixation in an individual did not lead to a reduction in the number of ideas generated. It is possible that these conflicting findings are due to the fact that a real group (Experiment 1) was being compared with an individual (Experiments 2 and 3). What would make the comparison

more valid is if it was known whether or not the same processes that operate at the individual level (e.g., Experiments 2 and 3) are operating at the group level (e.g., Experiment 1). However, at this point, the hypothesis that fixation contributes to the productivity deficit cannot be supported.

#### Applied Implications

From the findings in the present study, some changes to the structure of brainstorming sessions would seem beneficial. If the goal of the organization is to engage in a divergent thinking task and seek to generate a wide variety of ideas/solutions to the problem, then it would seem that they should avoid a group session. Instead, the organization should split up their brainstorming group into non-interacting individuals. Then, the ideas generated by these individuals should be pooled.

If the goal of the session is to generate a highly unique idea, then again, interaction of the group members should be inhibited. Furthermore, given that novelty slightly rises with time, the brainstorming session needs to be of adequate length. On the other hand, if the organization wants to explore a few categories in depth, then interaction among the members should be encouraged.

It would seem quite possible that at some point the members of a brainstorming group would feel that their ideas are quite similar to one another. It is possible that fixation is taking place and that their ideas are conforming to their partners' ideas. To break out of this conformity, taking a break would help alleviate fixation. After taking an adequate break, they should observe an improvement in their ideation, especially in terms of the quantity and variety of ideas.

## Future Directions

The present study was the first to observe fixation in brainstorming. Given this finding, there are many possible routes for future research. Using a very controlled paradigm, fixation in the form of conformity was observed at the individual level in Experiments 2 and 3. Fixation appeared to be taking place in a group setting in Experiment 1, but this should be further verified. This could be studied in a variety of ways. For example, three confederates could be paired with a single participant. Such a design would allow for further study of an individual's ideas in the presence of a controlled group setting. Alternatively, a real group with no confederates could be used and the ideas suggested by each person could be analyzed in terms of the other members' contributions.

Experiment 3 found a couple significant effects of incubation, but other analyses did not reach significance. It is predicted that a more effective incubation period would lead to bigger incubation effects. Future studies could manipulate incubation length to find if time increases the effects. Smith & Blankenship (1989) found that incubation effects increased with time. Additionally, the forgetting fixation hypothesis predicts that incubation will be strongest when a context change takes place (Smith, 1995b). Thus, the incubation task should be manipulated (e.g., relaxation, demanding cognitive task, different brainstorming topic) to find which type of intervening task leads to the greatest benefits.

Another future direction for incubation experiments would be to manipulate what takes place after the incubation interval. In Experiment 3, participants were exposed to

any ideas from the confederate following the break. In the case of the fixating conditions, this led to numerous productivity benefits. However, in a real world setting, a brainstorming group would likely resume interaction after taking a break. Therefore it is important to test whether or not breaks are still effective in the situation where idea exchange takes place following an incubation interval.

Fixation was observed in Experiments 2 and 3 when participants were exposed to ideas from several typical categories. It is not known if fixation in brainstorming will occur if participants are exposed to other types of ideas. A future study could manipulate the level of novelty of the ideas a participant is exposed to (e.g., highly typical, moderately novel, highly novel). Additionally, the homogeneity of ideas could be manipulated in another future experiment. With the exception of the twenty-examples condition in Experiment 2, participants in the last two experiments received only a single idea from each typical category. It is possible that conformity will occur at different rates if a participant was given four ideas from a single typical category versus one idea from four typical categories.

The present study investigated fixation in brainstorming using the “ways in which to improve your university” brainstorming problem. This topic was chosen because it is an area that participants would be very familiar with and there are limitless number of ideas a participant could suggest as an answer to this problem. To ensure that fixation is not limited to just the present study, other brainstorming topics should be tested. A more practical topic with limited solutions might give this line of research external validity in the eyes of an organization.

## Conclusions

Brainstorming is a common technique used to promote idea generation. For a myriad of reasons, it is not as efficient as it should be. The present study has found that fixation does take place in brainstorming. This contributes to a person conforming their ideas to the ideas they are exposed to as well as reducing the novelty of their own ideas. Additionally, in a group setting, the exchanging of ideas leads to a reduction in the variety of ideas generated. Despite these consequences of brainstorming, fixation does not appear to account for the productivity deficit in brainstorming.

The present study has revealed a number of new findings. Fixation was found to occur when one is exposed to another person's ideas in a brainstorming task. Using a new, objective way to assess novelty of generated ideas, it was found that fixation leads to a reduction in the novelty of one's ideas. Temporal analyses provided insight into how various measures (quantity, variety, novelty) fluctuate over the course of a brainstorming session. Lastly this study showed that taking a break could lead to increasing the effectiveness of a brainstorming session.



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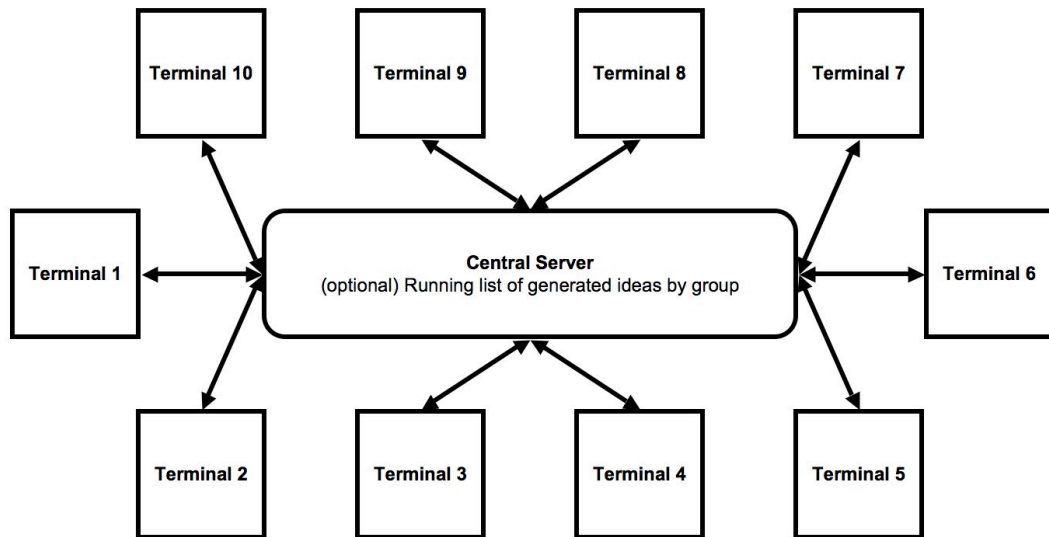
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## APPENDIX A

## ILLUSTRATION OF AN ELECTRONIC BRAINSTORMING SYSTEM



## APPENDIX B

CATEGORIES USED IN THE THREE EXPERIMENTS. FREQUENCY AND NOVELTY SCORES ARE BASED ON INDIVIDUALS IN EXPERIMENT 1

CATEGORY	FREQUENCY	NOVELTY SCORE
Expansion	3	33.33
Employment	4	25.00
Volunteer	9	11.11
Publicity	13	7.69
Health	19	5.26
Corps	23	4.35
Library	28	3.57
Admissions	31	3.23
Organizations	35	2.85
Tutors	43	2.33
Diversity	43	2.33
Rec	44	2.27
Advisors	47	2.13
Beautification	48	2.08
StudentLife	51	1.96
Traditions	54	1.85
Teachers	60	1.67
Safety	66	1.52
Entertainment	70	1.43
Tech	87	1.15
Costs	99	1.01
Academics	103	0.97
Improvements	119	0.84
Buildings	124	0.81
Dorms	125	0.80
Parking	131	0.76
Class	146	0.68
Sports	157	0.64
Food	165	0.61
Transportation	172	0.58

## APPENDIX C

## IDEAS EXEMPLIFIED BY THE CONFEDERATE IN EXPERIMENT 2

## One-example Condition

Time	Category	Idea	1st Alternate	2nd Alternate
0:10	Transportation	Add more busses to off-campus routes	Less traffic on campus	Make a designated place for bikers to ride

## Four-examples Condition

Time	Category	Idea	1st Alternate	2nd Alternate
0:10	Transportation	Add more busses to off-campus routes	Less traffic on campus	Make a designated place for bikers to ride
5:00	Class	Don't require attendance in class	There should always be a curve	No Chemistry labs at night
10:00	Food	Add a Tomato Bar to the Northside dorms	More varied meal plans	Healthier food options
15:00	Sports	Create a men's soccer team	Better football team	Advertise sports other than football and basketball

## Ten-examples Condition

Time	Category	Idea	1st Alternate	2nd Alternate
0:10	Transportation	Add more busses to off-campus routes	Less traffic on campus	Make a designated place for bikers to ride
2:00	Parking	Add more parking garages around campus	Bring the price of the night permit back down	More parking lots closer to the dorms
4:00	Class	Don't require attendance in class	There should always be a curve	No Chemistry labs at night
6:00	Improvements	Fix the sidewalks	Have more maps located around campus	Bike racks at every building
8:00	Dorms	Put new furniture inside the dorms	Better heating in the dorms	No more crazy RA's in the dorms
10:00	Food	Add a Tomato Bar to the Northside dorms	More varied meal plans	Healthier food options
12:00	Costs	Get rid of the flat-	Provide free	Give a larger

		rate tuition	scantrons	rebate for finishing in 4 years
14:00	Sports	Create a men's soccer team	Better football team	Advertise sports other than football and basketball
16:00	Academics	Move back the add/drop deadline	Shorter semesters	More course options
18:00	Buildings	Fix up the old buildings	More elevators in Rudder tower	Make building construction go faster

### Twenty-Examples Condition

Time	Category	Idea	1 <sup>st</sup> Alternate	2 <sup>nd</sup> Alternate
0:10	Transportation	Add more busses to off-campus routes	Make a designated place for bikers to ride	Have the busses run on a more consistent schedule
0:30	Transportation	Less traffic on campus	More drivers for busses	Make it easier for me to drive through campus
2:00	Parking	Add more parking garages around campus	More parking lots closer to the dorms	Fix the pay machine at West Campus Garage
2:30	Parking	Bring the price of the night permit back down	Lower the cost of parking tickets	Fewer 24hr reserved parking spaces
4:00	Class	Don't require attendance in class	No Chemistry labs at night	Less HW for each class
4:30	Class	There should always be a curve in class	No more PowerPoint presentations in class	More guest lectures in class
6:00	Improvements	Fix the sidewalks	Bike racks at every building	More recycling bins around campus
6:30	Improvements	Have more maps located around campus	Build overhangs to keep you dry when it rains	Better signs around campus
8:00	Dorms	Put new furniture inside the dorms	More housing on campus	More modern housing on campus



8:30	Dorms	Better heating in the dorms	No more crazy RA's in the dorms	Dorms with kitchens in them
10:00	Food	Add a Tomato Bar to the Northside dorms	Healthier food options	Add a Starbucks on campus
10:30	Food	More varied meal plans	Cheaper food at Sbisa	Better food vending machines
12:00	Costs	Get rid of the flat-rate tuition	Stop raising tuition	Give a larger rebate for finishing in 4 years
12:30	Costs	Lower the price of textbooks	Provide free scantrons	More financial aid
14:00	Sports	Create a men's soccer team	Advertise sports other than football and basketball	Recruit better athletes for our teams
14:30	Sports	Better football team	Give better basketball seats to students	Fix the moving bleachers at Kyle Field
16:00	Academics	Move back the add/drop deadline	More course options	A more fair way of registering for classes
16:30	Academics	Shorter semesters	Make labs worth more credit	Allow more than 2 Q-drops
18:00	Buildings	Fix up the old buildings	Make building construction go faster	Update the MSC before I graduate
18:30	Buildings	More elevators in Rudder tower	Air conditioning in Blocker	Put in more windows in Blocker

## APPENDIX D

## IDEAS EXEMPLIFIED BY THE CONFEDERATE IN EXPERIMENT 3.

Time	Category	Idea	1 <sup>st</sup> Alternate	2 <sup>nd</sup> Alternate
0:10	Transportation	Add more busses to off-campus routes	Less traffic on campus	Make a designated place for bikers to ride
3:00	Class	Don't require attendance in class	There should always be a curve	No Chemistry labs at night
6:00	Food	Add a Tomato Bar to the Northside dorms	More varied meal plans	Healthier food options
9:00	Sports	Create a men's soccer team	Better football team	Advertise sports other than football and basketball

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