ASYNCHRONOUS IDEA GENERATION

by

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ABSTRACT

ASYNCHRONOUS IDEA GENERATION

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The studies examined the role of providing review sessions during a brainstorming task. Participants were asked to generate ideas either as pair or individually. It was expected that participants who were provided time to review their own as well as their partners' ideas would generate more ideas than those who were not provided a separate review session. Additionally, it was expected that when the review session was provided, participants who generated ideas alone would perform better than those who generated ideas as a pair. Results of Study 1 supported these hypotheses.

Study 2 was conducted to understand the factors that may have led to strong effects in Study 1. It was expected that participants who reviewed previously unseen ideas would generate more ideas than those who reviewed previously seen ideas. Again, it was expected that those who generated ideas alone would benefit the most when shown previously unseen ideas. None of the hypotheses were supported in Study 2, but the results were in the expected direction.

Study 1 and 2 showed that providing a review session helped participants generate more ideas. It did not seem to matter whether these ideas were previously seen or unseen. Further research is needed on ways to best provide the review session.

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CHAPTER 1

INTRODUCTION

Brainstorming was developed by Osborn in the 1940s and 1950s to enhance problem solving, decision making, creativity and idea generation. Participants are given a topic and asked to come up with as many ideas as possible in order to facilitate the generation of novel and creative solutions. Today, it has become a commonly used activity and is frequently used in corporate, academic and other settings. In the early days, brainstorming was done face-to-face (FTF), either verbally or by writing down the ideas. However, research has shown that the number of ideas generated in these face-to-face groups is significantly lower than those generated by an equal number of individuals while brainstorming alone (nominal groups) (Diehl & Stroebe, 1987; Mullen, Johnson & Salas, 1991). Further investigation of this phenomenon revealed that groups faced several obstacles while performing the task. Some of these were production blocking (Lamm & Trommsdorf, 1973), social loafing (Karau & Williams, 1993), evaluation apprehension (Diehl & Stroebe, 1987; Lamm & Trommsdorf, 1973) and matching the overall group performance to the low performers in the group (Paulus & Dzindolet, 2008). Electronic brainstorming (EBS) was developed to overcome some of these obstacles. EBS is a computer mediated approach that allows participants to contribute ideas by typing them instead of waiting for their turn to speak. The need to collaborate across cities and countries for business development and economic growth has made EBS even more popular over the last decade. The

type of software packages being used has expanded from specially created packages like the Group Systems Software (Nunamaker, Dennis, Valacich, Vogel, & George, 1991) to more readily available options like the messenger programs (for example - Yahoo, AOL etc) and emails.

The use of EBS reduces the productivity gap between nominal and real groups (DeRosa, Smith & Hantula, 2007). All the members in an EBS group can contribute simultaneously to the session (Dennis & Valacich, 1993; Pinsonneault & Barki, 1999; Valacich, Dennis & Connolly, 1994). This leads to a drastic increase in the number of ideas generated relative to FTF. Initial research showed that when real groups use the FTF method, the increase group size leads to an increase in the total number of ideas generated (Bouchard & Hare, 1970; Mullen et al., 1991). The comparison between real and nominal groups using FTF revealed that nominal groups outperformed the real groups (Diehl & Stroebe, 1987; Taylor, Berry & Block, 1958; Mullen et al., 1991). Nominal groups also outperform small EBS groups, but large EBS groups (with eight or more members) have been shown to perform better than nominal groups of the same size (Dennis & Gallupe, 1993; Dennis & Valacich, 1999; Pinsonneault, Barki, Gallupe & Hoppen, 1999; Valacich et al., 1994).

Although EBS has many advantages over the traditional FTF method and is an easy to use technique, there are some disadvantages to the EBS method as well. EBS affects nominal and real groups differently. Nominal groups generate ideas at their own pace and can easily follow their chain of thought without being disrupted by another person's ideas. Based on an associative memory perspective, the SIAM model (Nijstad & Stroebe, 2006) suggests that this

would help them generate more ideas. According to this model, a particular concept (in this case, an idea) is associated with multiple semantically related concepts. One idea leads to the activation of these related concepts which aids in further idea generation. This process is conceptualized as a chain reaction. Any distraction disrupts this chain reaction causing cognitive interference. The train of thought is abandoned and depth of the category being explored is reduced. Participants who brainstorm individually are not distracted by another participant's ideas should be able to follow their thought process without disruption. However, groups may find it difficult to adhere to their flow of thought. Paying attention to other members' ideas could disrupt their thought process causing distraction and information overload (Santanen, Briggs, & de Vreede, 2004; Valacich et al., 1994).

On the other hand, when people work in a group and exchange ideas, they may cognitively stimulate each other (Paulus & Brown, 2007). An idea generated by one member of the group has the potential to stimulate idea generation for other members in the group (Dennis and Valacich, 1993; Lamm & Trommsdorff, 1973). Depending on the semantic content of the idea, it can lead to ideas similar to what were being discussed or can aid in exploration of newer categories of ideas (Paulus, 2000). This stimulation effect can occur only if participants pay attention to these ideas (Dugosh, Paulus, Roland, & Yang, 2000; Paulus & Yang, 2000). If each idea generated by another member of the group has potential stimulation benefits, then increasing the number of group members should increase the amount of cognitive stimulation (Dennis and Valacich, 1993; Gallupe, Dennis, Cooper, Valacich, Bastianutti & Nunamaker, 1992; Valacich et al., 1994). When group size is four or smaller, the benefits of stimulation may

be outweighed by distraction and groups may perform poorly as compared to individuals. Increasing the group size should lead to an exchange of large number of ideas, and the stimulation effect of these ideas could be enough to overcome possible distraction (Paulus & Brown, 2007). Meta-analytic studies have shown that although group performance is lower than nominal groups when group size is small, group performance steadily increases with an increase in group size. When group size is four, the trend begins to change and at a group size of eight (Derosa et al., 2007) or nine (Dennis & Williams, 2005) groups perform significantly better than an equal number of individuals.

Based on the SIAM model, reading an idea provides a cue to probe long term memory and that should aid in further idea generation (Nijstad & Stroebe, 2006). The semantic content of the idea determines the type of possible benefit. If the idea being read is semantically different from the ones being generated, it can activate knowledge that was previously unavailable. This will allow the participant to generate ideas from a larger variety of semantic categories. However, since the new idea is semantically different from previously generated ones, it may also shorten the current train of thought and cause cognitive interference. A semantically related idea might not cause as much distraction; however, it may have less stimulation value than an idea with novel or semantically diverse content. A study by Dugosh & Paulus (2005) examined the effects of cognitive stimulation and social comparison and found that exposure to a high number of ideas under a high social comparison condition was related to more idea generation. Other studies that have tried to explain this cognitive stimulation effect have shown that idea generation was enhanced both during and after sharing of ideas (Dugosh et al., 2000). Paulus and

Yang (2000) demonstrated that providing time for participants to reflect on their ideas after the exchange process, enhanced idea generation.

Considering the various advantages and disadvantages of individuals and groups, one useful approach might be to develop a different method that maximizes the potential of EBS and uses both individual ideation and group stimulation. One such attempt has been made by Girotra, Terwiesch & Ulrich (2010) by creating what they call the 'hybrid process'. Participants were allotted a total of 30 minutes of brainstorming time to work on a variety of problems. They asked participants to work individually for the first ten minutes and work together for the rest of the time. The hybrid process generated three times more ideas than the 'team process' (real groups). However, there was no individual control group. Therefore, it is not clear whether the hybrid process helps real groups that use the team process outperform individuals who use the same process.

Other studies have used a different kind of hybrid process called asynchronous brainstorming. In this paradigm, participants work in a group, however, they submit their ideas at different points in time. Using this paradigm should allow group members to follow their chain of thought without being disrupted, while also being able to gain stimulation from other members' ideas. However, asynchronous brainstorming has not been well researched. De Vreede, Briggs and Reiter-Palmon (2010) examined asynchronous brainstorming in large groups. These large EBS groups were comprised of smaller groups that either completed the entire brainstorming process, from start to finish (parallel mode) or built on the work provided by the previous subgroups (serial mode). Their results showed that serial processing was better suited

for tasks that require in-depth processing and elaboration, while parallel processing was appropriate for tasks that demand multiple new ideas. Again, there was no individual control group. Asynchronous brainstorming in a large EBS group was compared to individual brainstorming in a study by Dornburg, Stevens, Hendrickson and Davidson (2009). Participants were asked to come up ideas at least once every four days. There was no difference in the quantity of ideas generated between the individuals and the group. Individuals outperformed the group in originality, feasibility and effectiveness. Among the problems with this study were that the duration of brainstorming was not controlled and it only involved one interactive group of 30. This large EBS group was compared to 39 individuals performing the same task. Therefore, it is difficult to generalize the results found in this study.

Ocker, Fjermestad, Hiltz and Johnson (1998) compared FTF brainstorming with two different types of EBS (synchronous and asynchronous) and a combination group. Both the EBS groups communicated using a computer conferencing system. However, the synchronous groups worked at the same time in the same room, while members of the asynchronous groups worked from different locations at different times. In the combination group participants first worked FTF and later worked asynchronously. The amount of time allowed for communication among group members in the asynchronous conditions was not controlled. However, all groups received two weeks to work on the given task. The researchers were interested in quality and creativity of the solutions generated. The combined group generated significantly more creative solutions and better quality solution than the asynchronous, the synchronous and the FTF group. Another

interesting finding was that there were no significant differences in the creativity and quality of the solutions generated by the asynchronous and synchronous groups.

In sum, brainstorming groups have the advantage of stimulation along with disadvantage of distraction. Although brainstorming individuals are not distracted, they lack the advantage of stimulation. Once individuals run out of ideas, they do not have the advantage of viewing another person's ideas in order to generate more. If groups are able to have the benefit of stimulation through other members' ideas without being distracted while generating their own ideas, then this should lead to significantly more idea generation than the traditional EBS method. The following studies are aimed at developing a new EBS paradigm that overcomes some of the shortcomings of previous studies. These studies will attempt to systematically examine the effect of reviewing ideas on idea generation.

CHAPTER 2

STUDY 1

Previous studies have not compared the number of ideas generated with the mixed or hybrid procedures, and they have not provided a comparison with nominal groups. To overcome these limitations, the current study compared the number of ideas generated in four variations of EBS using a 2 X 2 between-subjects factorial design. The four conditions employed were the Dyad-No Review, Dyad-Review, Alone-No Review and Alone-Review condition. Participants in three of the four conditions worked in pairs, while those in the Individual-No Review condition worked alone. In the Dyad-No Review condition pairs worked together for the entire time allotted, while those participants in the Alone-No Review condition worked alone for the entire time. Members of the Alone-Review condition worked alone most of the time; however, they were allowed to periodically view each other's ideas. Providing this review time allowed them to benefit from their partner's ideas, and they were also able to generate ideas without being distracted. The Dyad-Review condition allowed participants to generate ideas together as well as to periodically view the ideas that were previously submitted.

Group size research has shown that groups outperform individuals when the group size exceeds eight. However, in this study, the group size was two. Therefore, it was expected that individuals would outperform dyads (Derosa et al., 2007; Dennis & Williams, 2005).

H1: Alone-No Review > Dyad-No Review

As previously discussed, research has shown that exposure to ideas stimulates idea generation (Dugosh et al., 2000; Nijstad & Stroebe, 2006; Paulus & Yang, 2000; Paulus, 2000; Paulus & Brown, 2007). Based on these findings it was expected that exposure to ideas during periodic reviews should stimulate additional idea generation. The review period should enhance the number of ideas generated because of this stimulation effect in both of the review conditions.

H2a: Review > No Review

However, the novelty of the ideas being presented during the review period may play an important role in stimulation. Research has shown that not having seen the ideas previously enhances the stimulation value. Putman and Paulus (2009) asked participants to generate ideas either individually or in groups. Participants were later asked to select the best ideas in a group irrespective of the brainstorming setting (individual or group). Participants who generated ideas individually were better than groups at selecting the best ideas. Another study by Rietzschel, Nijstad and Stroebe (2006) found that when individuals and groups generate ideas and are asked to select the best ideas in the same individual and group setting, individuals and groups do not differ in idea selection. In this experiment, both individuals and groups had to evaluate only those ideas that they had previously seen in the brainstorming phase. However, in the Putman and Paulus (2009) study, participants who had brainstormed individually were seeing the other participants' ideas for the first time during the evaluation phase, but those who had brainstormed in a group had previously seen these ideas during the brainstorming phase. Based on these contradictory findings and the difference between the conditions, it appears that not having seen

the ideas before may have led to more careful evaluation of the ideas. Support for this perspective was also obtained by Kohn, Paulus and Choi (2011). They asked individuals and groups to build combinations of ideas using either rare or common ideas and found that those who brainstormed alone were more likely to use others' ideas to generate combinations, while those who brainstormed in a group were more likely to use their own ideas. These findings suggest that first exposure to others' ideas has a more stimulating effect than second exposure.

Participants working as a pair may also experience distraction while brainstorming and this may reduce the number of ideas generated as compared to the alone condition (Dennis & Williams, 2005). Therefore, it is predicted that participants who brainstorm alone and are exposed to their partner's ideas for the first time in the review phase (Alone-Review) will generate more ideas than participants who worked in a pair and were exposed to their partner's ideas for the second time in the review phase (Dyad-Review).

H2b: Alone-Review > Dyad-Review

2.1 Method

2.1.1 Participants

A total of 146 undergraduate students from the University of Texas at Arlington voluntarily participated in the study to fulfill introductory psychology class requirements. Students also had the option of participating in other experiments or writing papers to fulfill the requirement. Participants were randomly assigned to one of the four experimental conditions. Data from 26 participants was excluded from the analyses due to errors in experimentation

(failure of participants to comply with instructions, technical problems with the computer etc). After exclusions, data from a total of 120 students were used for the analyses. The average age of the participants was 20.63 years (*SD* = 6.06). There were 84 females and 32 males. Three of the four conditions contained 15 dyads while the Alone Review condition contained 15 nominal dyads. Data from 30 individual participants were collected for the Alone Review condition and the data from two consecutive participants was then pooled together to create a nominal dyad.

2.1.2 Design and Procedure

The study used a 2 (Dyad vs. Alone) X 2 (No Review vs. Review) between-subjects factorial design. Each session was conducted with one to two participants. All the participants except the ones in the Alone-No Review condition performed the task in pairs.

Informed consent was obtained from the participants before providing them with the instruction packet. Participants were provided instructions about the task, the rules of brainstorming (Osbron, 1957; Paulus, Nakui, Putman & Brown, 2006) and the software to be used. All the participants submitted their ideas using the AOL Instant Messenger program. After the initial instructions, participants were provided with the brainstorming topic – "Please list all the possible ways in which UTA could be improved." Once all the questions about the session were answered, the participants began the brainstorming task. Up to this point, the procedure for all the conditions was the same. The instructions varied slightly depending on the condition. The length of the task was 30 minutes for all the conditions.

Participants in the Dyad-No Review and the Alone-No Review conditions were asked to brainstorm for 30 minutes continuously. However, the 30 minutes were broken down into two distinct phases for the Dyad-Review and the Alone-Review conditions – brainstorming and review phases. Participants were first provided with eight minutes to brainstorm, followed by a three minute review period. The two phases continued in this alternating manner for a total of 30 minutes, creating an 8-3-8-3-8 pattern.

Participants in the Alone-Review condition were told that they would not be able to view each other's ideas in the beginning, but they would be allowed a separate time to read each other's and their own ideas. Ideas generated by each participant were pasted in the partner's chat window. Those in the Dyad-Review condition were informed their ideas would be visible to each other while they were typing. However they would also be given some additional time to read through all the ideas at a later time. Participants in both these conditions, the Alone-Review and Dyad-Review, were allotted 24 minutes of brainstorming time and 6 minutes of review time. The participants in the Dyad and Alone No Review conditions had 30 minutes for brainstorming and no separate review period.

After the 30 minutes were over, participants in all the conditions (except the Alone-No Review condition) completed a recall task. Participants were asked to recall the ideas submitted by their partner and list the ideas that they viewed as the best five. The maximum time for this task was 3 minutes. Finally, all the participants completed a questionnaire about the task and their performance. See Appendix B for the questionnaire items.

2.1.3 Dependent Variables

The number of ideas generated was the main variable of interest in this study. Since the brainstorming time provided for the different conditions was not the same, number of ideas was examined in three different ways – overall quantity, quantity in 24 minutes and rate of ideas. Overall quantity involved a comparison of the mean number of ideas generated across the different conditions, irrespective of the total brainstorming time provided. This measure was used to provide an overall assessment of the number of ideas generated across the conditions. Quantity in 24 minutes involved a comparison of the mean number of ideas generated in the first 24 minutes (for Dyad and the Alone No-Review conditions) with the mean number of ideas generated in Dyad and Alone Review conditions. This comparison controlled for the difference in brainstorming time. Rate of ideas was calculated by dividing the total number of ideas generated by the total amount of brainstorming time.

2.2 Results

A one-way ANOVA was first conducted to test for differences in the recall scores among the three conditions that were asked to recall their partner's ideas – Alone-Review, Dyad-Review and Dyad-No Review. The results showed that there was no significant difference among the recall scores across these conditions, F (2, 41) = 1.265, p = .180, η_p^2 =.080. Please refer to Table 1 for recall scores by condition.

Table 1: Average Recall scores across all three conditions in Study 1

	Recall Mean (SE)
Alone-Review	4.679 (.225)
Dyad-No Review	4.167 (.217)
Dyad-Review	4.667 (.217)

The data were then analyzed using a 2(Dyad vs. Alone) X 2(No Review vs. Review) between subjects factorial ANOVA. Three separate ANOVAs were conducted to test the three dependent variables – total number of ideas, ideas in 24 minutes and rate of ideas (Refer to Table 1 for Descriptive Statistics). The ANOVA for the total number of ideas generated revealed that the main effects of both team type, F (1, 55) = 3.915, p = .053, η_p^2 =.066, and review, F (1, 55) = 3.231, p = .078, η_p^2 =.055, approached significance. There was no significant interaction between team type and review phase, F (1, 55) = .895, p = .348, η_p^2 =.016. The contrast comparison between Alone-Review and Dyad-Review showed that the review session benefitted participants who worked alone more than those who worked in a pair, F (1, 55) = 4.204, p = .045, η_p^2 =.071.

The ANOVA for ideas in 24 minutes showed a significant main effect of team type, F (1, 55) = 4.363, p = .041, η_p^2 =.073. Participant who worked alone generated significantly more ideas in 24 minutes than participants who worked as a dyad. Participants who were allotted a review session generated significantly more number of ideas in 24 minutes than participants who

were not allotted the review session, F (1, 55) = 22.724, p = .001, η_p^2 = .176. The interaction effect was not significant F (1, 55) = 1.389, p = .244, η_p^2 =.025. However, the contrast comparison revealed that reviewing the ideas increased performance of participants who worked alone more than those who worked in a pair, F (1, 55) = 5.245, p = .026, η_p^2 =.087.

The analysis for rate of ideas revealed a significant main effect of team type F (1, 55) = 4.405, p = .040, η_p^2 =.074. Participant who worked alone generated significantly more ideas per minutes than participants who worked in a group. There was also a significant main effect of the review session, F (1, 55) = 17.390, p < .001, η_p^2 = .240. Participants who were allotted a review session generated significantly more of ideas per minute than participants who were not allotted the review session. The interaction effect was not found to be significant, F (1, 55) = 1.380, p = .245, η_p^2 =.024. The contrast comparison between Alone-Review and Dyad-Review showed that participants in the Alone-Review condition had a higher rate of ideas than those in the Dyad-Review condition, F (1, 55) = 5.265, p = .026, η_p^2 =.087. Please refer to Table 2 for descriptive statistics.

Table 2: Average Quantity of ideas across all the conditions in Study 1

	Overall Mean (SE)	24 Minutes Mean (SE)	Rate Mean (SE)
Alone	84.900(5.251)	79.833(4.701)	3.226(.196)
Dyad	70.333(5.160)	66.067(4.619)	2.651(.192)
No-Review	71.000(5.160)	61.667(4.691)	2.367(.192)
Review	84.233(5.251)	84.233(4.701)	3.510(.196)
Alone-No Review	74.800(7.297)	64.667(6.533)	2.493(.272)
Alone-Review	95.000(7.553)	95.000(6.672)	3.958(.281)
Dyad-No Review	67.200(7.297)	58.677(6.533)	2.240(.272)
Dyad-Review	73.467(7.297)	73.467(6.533)	3.061(.272)

2.3 Discussion

As expected participants who reviewed the ideas generated significantly more ideas than participants who did not review the ideas for ideas generated in 24 minutes and rate of idea generation. Similar trends were seen when total number of ideas were examined. However, these results were found to be marginally significant. This is not surprising since the amount of brainstorming time was not equivalent to the other conditions. However, this comparison provides important information about how to utilize available brainstorming time. Keeping some time aside to review the ideas may help generation of more ideas than simply having more brainstorming time without any review. Overall, these findings are consistent with previous

research which suggest that exposure to ideas of others can stimulate generation of additional ideas (Dugosh et al, 2000; Paulus & Yang, 2000; Paulus, 2000; Paulus & Brown, 2007).

Providing the review session was expected to affect participants differently depending on whether they worked alone or as a pair. That is, reviewing the ideas was expected to help individuals generate more ideas than the dyads. The results supported this hypothesis. These findings also support previous research on stimulation effects of ideas (Dugosh et al, 2000; Paulus & Yang, 2000; Paulus, 2000; Paulus & Brown, 2007) as well as EBS research which suggests that participants experience distraction when working as a team (Dennis & Valacich, 1993; Gallupe et al., 1992; Santanen et al., 2004; Valacich et al., 1994).

Consistent with EBS literature, individuals generated more ideas than dyads. This implies that simple exposure to ideas from another person during brainstorming has distraction effects which outweigh any benefits of stimulation (Derosa et al 2007; Dennis & Williams, 2005).

CHAPTER 3

STUDY 2

In the previous study it was found that reviewing ideas aided in further idea generation. This effect was especially pronounced when participants were working alone rather than as a pair. Although participants in Alone-Review and Dyad-Review both had a chance to review the ideas, there was one major difference. Participants in the Alone-Review condition were seeing their partner's ideas for the first time since they were working only on their own ideas while brainstorming. Therefore, the ideas presented to them in the review phase were not previously seen. In the Dyad-Review condition, participants were also presented with their partner's ideas. However, they had previously seen these ideas while they were brainstorming. Hence, the ideas in the review phase were not new to them. Consistent with previous research, seeing new ideas may have had a more stimulating effect (Kohn et al., 2011; Nijstad, Diehl & Stroebe, 2003; Nijstad, Stroebe, Lodewijkx, 2003; Putman and Paulus, 2009) and therefore facilitating the performance of participants in the Alone-Review condition. The Alone-Review condition and the Dyad-Review condition differed in one more aspect. Participants in the Alone-Review condition worked alone while generating ideas, while those in the Dyad-Review condition worked as a pair. Therefore, it is possible that participants in the Dyad-Review condition were distracted by their partner's ideas while brainstorming as suggested by some of the EBS literature (Dennis & Valacich, 1993; Gallupe et al., 1992; Santanen et al., 2004; Valacich et al., 1994).

Since there are two possible contributing factors to the differences between these two groups, the second study was designed to understand which of the two factors was responsible for this difference. In Study 1, the Alone-Review participants saw ideas that they had not seen previously (Alone-New ideas), while the Dyad-Review participants saw ideas that they had previously seen while brainstorming (Dyad-Old ideas). To assess the influence of each factor separately, two new conditions were designed. In one condition, participants who worked alone had a chance to review previously seen ideas (Alone-Old ideas) and in the other condition participants worked in pairs but were provided new ideas in the review phase (Dyad-New ideas).

If newer ideas have greater stimulation value than previously seen ideas (Kohn et al., 2011; Nijstad et al., 2003; Putman and Paulus, 2009), then the conditions with the new ideas in the review phase will generate more ideas than those with previously seen ideas in the review phase

H1: Review-New > Review -Old

If distraction during idea generation is the cause of lower performance of dyads as compared to individuals (Dennis & Valacich, 1993; Gallupe et al., 1992; Santanen et al., 2004; Valacich et al., 1994), then participants in the Alone conditions should perform better than those in the Dyad condition. However, we do not expect this difference to be significant based on our findings in Study 1.

H2: Alone > Dyad

However, if both newness of the ideas in the review phase and distraction in the brainstorming phase are contributing factors, then Alone-New should generate the most number

of ideas as compared to all the other conditions. The Alone-New condition would have both the benefits – seeing new ideas in the review phase and no distraction in the brainstorming phase. Dyad-new and Alone-Old, both only had one advantage each, seeing new ideas and no distraction, respectively. Whereas the Dyad-Old condition had no advantage – no new ideas in the review phase and could have had distraction in the brainstorming phase. Generating ideas in a team can have both stimulating and distracting effects. Group size research suggests that the effects of stimulation may be outweighed by the effects of distraction when the group size is small (Derosa et al 2007; Dennis & Williams, 2003). Thus distraction should have a stronger effect than stimulation during brainstorming for participants in the dyad conditions. However, providing participants with new ideas in the review phase could outweigh the negative effects of distraction and help them perform better than those who are provided with previously seen ideas.

H3: Alone-New > Dyad-New, Alone-Old, Dyad-Old

3.1 Method

3.1.1 Participants

A total of 162 undergraduate students from the University of Texas at Arlington participated in the study to fulfill introductory psychology class requirements. As before, their participation was voluntary and they had the option of participating in other experiments or writing papers to fulfill the requirement. Participants were randomly assigned to one of the four experimental conditions. Data from 136 participants was excluded from the analyses due to errors in experimentation (failure of participants to comply with instructions, technical problems with the computer etc). After exclusions, data from a total of 136 students were used for the

analyses. The average age of the participants was 20.87 years (*SD* = 4.44). There were 88 females and 48 males. Three of the four conditions contained 17 dyads while the Alone Review condition contained 17 nominal dyads. Data from 34 individual participants were collected for the Alone-Old condition and as before ideas from two consecutive participants were then pooled together to create a nominal dyad.

3.1.2 Design and Procedure

The Dyad-Old and the Alone-New conditions were the same as the Dyad-Review and Alone-Review conditions in Study 1, respectively. The two new conditions - Dyad-New and Alone-Old, followed the same 8-3-8-3-8 pattern of brainstorming and review. Participants in the Dyad-New condition generated ideas as a pair, like those in the Dyad-Old condition. However, in the review phase, those in the Dyad-New condition were provided with ideas that were generated by a group from the Dyad-Old condition (new ideas). The participants in the Alone-Old condition brainstormed alone and were provided only their own ideas in the review phase (old ideas).

Unlike Study 1, this study used a one-way between subjects ANOVA to test the hypotheses. A two-way ANOVA was not appropriate for this study as the participants saw ideas from different number of participants in the review phase. In Study 1, participants in both the review conditions saw ideas from a total of two people – themselves and their partner. However, in Study 2, participants in the Alone-New, Dyad-Old and Dyad-New conditions saw generated by two people whereas participants in the Alone-Old phase only reviewed their own ideas.

The brainstorming topic and remaining procedure was the same as Study 1 and similar questionnaires administered at the end of the task (See Appendix C for the questionnaires). However, slight changes were made to the recall task. In Study 1, participants in all the conditions (except the Alone-No Review) were asked to list the best five ideas of their *partner*. Since most participants were able to list five, the recall task was modified to test the maximum number of ideas they could recall in three minutes. Additionally, participants in the Alone-Old condition were asked to recall as many of their *own* ideas since they did not have a partner.

3.1.3 Dependent Variables

Quantity was again the main variable of interest. However, this time only total quantity was measured since all the conditions brainstormed for the same amount of time – 24 minutes.

3.2 Results

A one way between subjects ANOVA was used to test for differences in recall scores across the four conditions showed significant differences, $F(3, 64) = 23.522$, $p < .001$, $\eta_p^2 = .524$. Participants in the Alone-Old condition ($M = 17.941$, $SE = .752$) recalled significantly more ideas than participants in any other condition at $p < .001$. This was expected as participants in the Alone-Old condition were simply asked to recall their own ideas. However, there were no significant differences in the number of ideas recalled by participants in the Alone-New, Dyad-Old and Dyad-New conditions. Please refer to Table 3 for the descriptive statistics.

The data were analyzed using a one-way between subjects ANOVA and planned contrast comparisons were used to test hypotheses. The ANOVA for the total number of ideas generated showed that there was no significant effect of condition, $F(3, 64) = 1.004$, $p = .397$, $\eta_p^2 = .045$.

The conditions in which brainstorming was performed alone (Alone-Old and Alone-New), did not generate significantly more ideas than conditions the dyad conditions (Dyad-Old and Dyad-New), t (3, 64) = 1.546, SE = 13.245, p = .127. Seeing new ideas in the review session (Alone-New and Dyad-New) as compared to old ideas (Alone-Old and Dyad-Old), did not significantly increase the number of ideas generated, t (3, 64) = .497, SE = 13.245, p = .621. Also, the prediction that participants in the Alone-New condition would generate the maximum number of ideas was not supported, t (3, 64) = .826, SE = 22.940, p = .412. Although there were no significant differences among the conditions, the trends were in predicted directions. The large amount of variance in the sample seems to have been a key contributor to the lack of significant differences. None of the hypotheses were supported.

Table 3: Average Quantity of ideas and Recall scores across all the conditions in Study 2

	Quantity Mean (SE)	Recall Mean (SE)
Alone-Old	82.706 (6.622)	17.941 (.752)
Alone-New	81.941 (6.622)	11.176 (.752)
Dyad-Old	68.412 (6.622)	10.676 (.752)
Dyad-New	75.765 (6.622)	10.206 (.752)

3.3 Discussion

None of the hypotheses were supported by the results of Study 2. Previous research suggested that exposing participants to new ideas would increase idea generation (Kohn et al., 2011; Nijstad et al., 2003; Putman and Paulus, 2009). However, the present study showed that

exposing participants to previously unseen ideas was no different than exposing participants to previously seen ideas. It was also expected that participants who generated ideas alone would perform better than those who generated ideas as a pair (Dennis & Valacich, 1993; Gallupe et al., 1992; Santanen et al., 2004; Valacich et al., 1994). Although the means were in the predicted directions, the results were not significant and this was consistent with results from Study 1.

In Study 1, participants who were provided time to review the ideas did significantly better than those who were not provided time to review ideas. In Study 2, when all the participants were given time to review the ideas, there were no differences among the conditions. Based on the findings from Studies 1 and 2, it seems that being able to review the ideas helps generate more, irrespective of whether the ideas are new or old. Based on the associative memory perspective, when a particular concept is activated, it leads to the activation of another concept. However, this does not mean that the initial concept is related only to one other concept. It is possible that the each concept activates another strongly related concept while temporarily suppressing other concepts that may not be as strongly related. When participants are allowed to review their previously submitted ideas, the same concepts may now activate other previously suppressed concepts leading to newer ideas. Therefore, the old ideas may have been looked at from a "new perspective". The new ideas on the other hand simply activated new concepts or new links between concepts and therefore led to further idea generation. Presenting old versus new ideas may have worked in different ways but both led to generation of more ideas.

Additionally, participants were provided the ideas generated by their partner or the other group without screening the ideas for redundancy. Timing was crucial in these studies and

removing redundant ideas would have required more time to read through the ideas before presenting them. Also, the time required to read all the ideas would vary per group, since it would depend on the number of ideas generated. Therefore, it is important to run a separate analysis by controlling for the number of non-redundant ideas that were presented. This would provide a clearer picture of the effect of presenting previously unseen ideas. Future studies may also want to consider alternate ways to control for redundant ideas.

The ability to focus on an idea while simultaneously generating another may vary from one individual to another. Future studies could examine the possible effects of certain individual differences like the ability to multi-task effectively. This ability can be measured using different polychronicity scales, for example the ten-item Inventory of Polychromic Values (IPV) developed by Bluedorn, Kalliath, Strube and Martin (1999) and the four-item Polychronic Attitude Index (PAI) developed by Kaufman-Scarborough and Lindquist (1999). An important factor in this regard is the working memory capacity which can be measured using the AOSPAN – automated operation span developed by Unsworth, Heitz, Schrock, & Engle (2005). Using both a self-report measure and an objective measure may prove useful to test the effect of multi-tasking ability on reviewing and brainstorming ideas.

Since these studies used dyads, it would be interesting to test the effects of each participant on the other. Analysis using an actor-partner interaction model – APIM (Kashy and Kenny, 2000) may provide useful insights into the brainstorming process between dyads. Does the productivity of one partner affect the productivity of the other? Does creativity of one participant increase or inhibit creativity of the other?

The current set of studies divided the 30 minute time period into eight and three minute blocks. But this may not be the only optimal way to divide the allotted time. Further studies could also vary the length of the time periods and the pattern in which they alternate in order to test which pattern works the best. Similar studies also need to be conducted with groups of three or more participants to test if the effectiveness of this method can be generalized beyond dyads.

Another possibility that needs to be considered is the effect of taking a break from idea generation. It would be important to determine if the increase in quantity of the ideas is due to reviewing other members' ideas or simply because the participants took a break from the idea generation task. A study by Paulus et al. (2006) showed that there was a small benefit of taking breaks when brainwriting procedures were used. However, this effect was weaker when electronic brainstorming was used. Even so, a future study to examine this would be important to obtain a thorough understanding of these results. Overall, the studies indicate that the review process is beneficial to additional idea generation. The key is to provide the review in a systematic manner without distracting participants during idea generation.

APPENDIX A

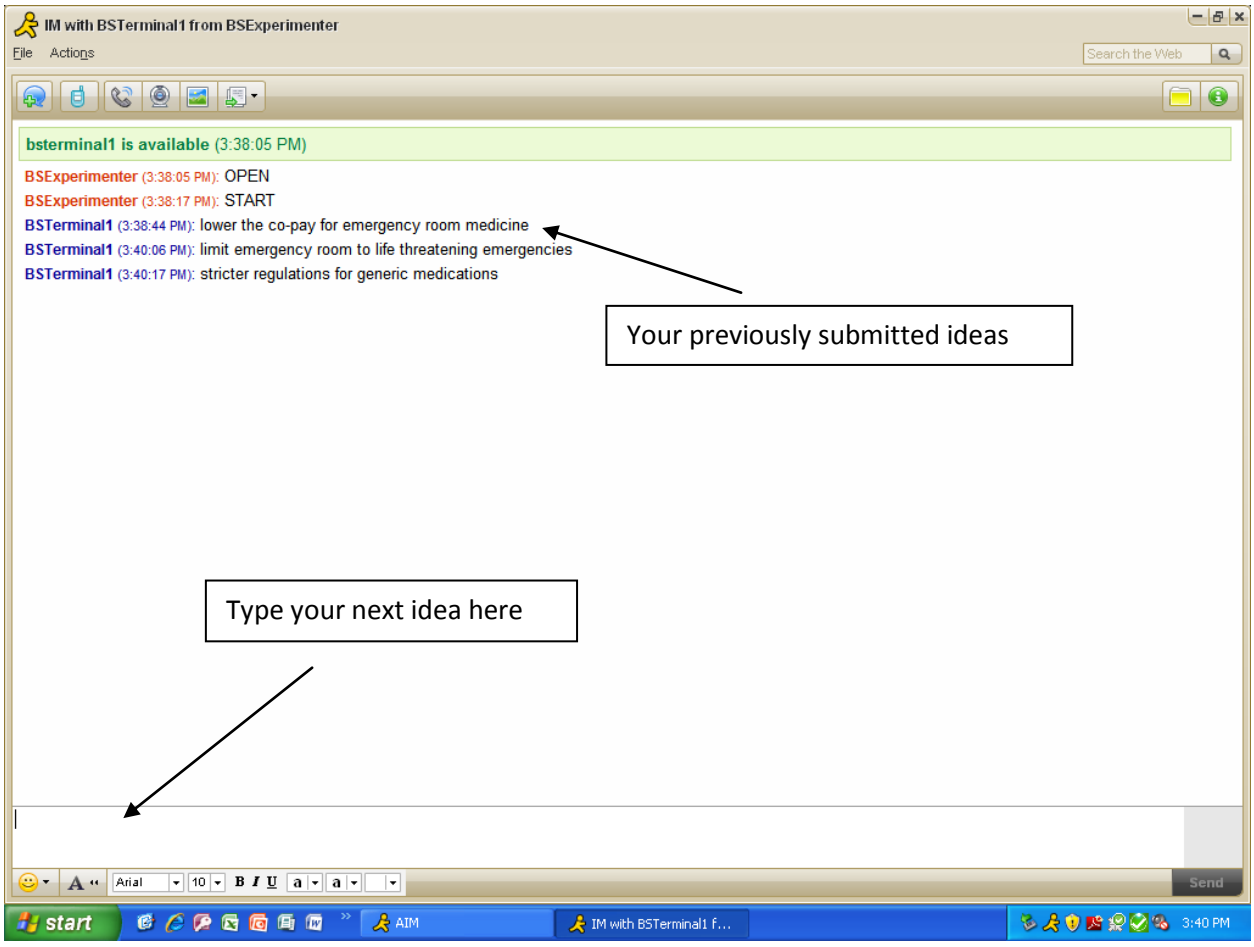
EXPERIMENTAL INSTRUCTIONS

Experiment Instructions (Alone-No Review)

You are about to participate in an experiment examining idea generation. In a minute you will be given a topic. Your job is to list as many ideas as possible for this topic. These ideas can be as short as a few words. You will submit your ideas by typing the idea into the program (AOL Instant Messenger – "AIM") and then pressing enter. Do not worry about perfect spelling or grammar.

You will be working on your own on this idea generation task. Each idea you submit will be sent to the Experimenter. However, the Experimenter will not communicate with you via AIM, except to tell you to "Start" and "Stop."

Here is a diagram of how to type in ideas:

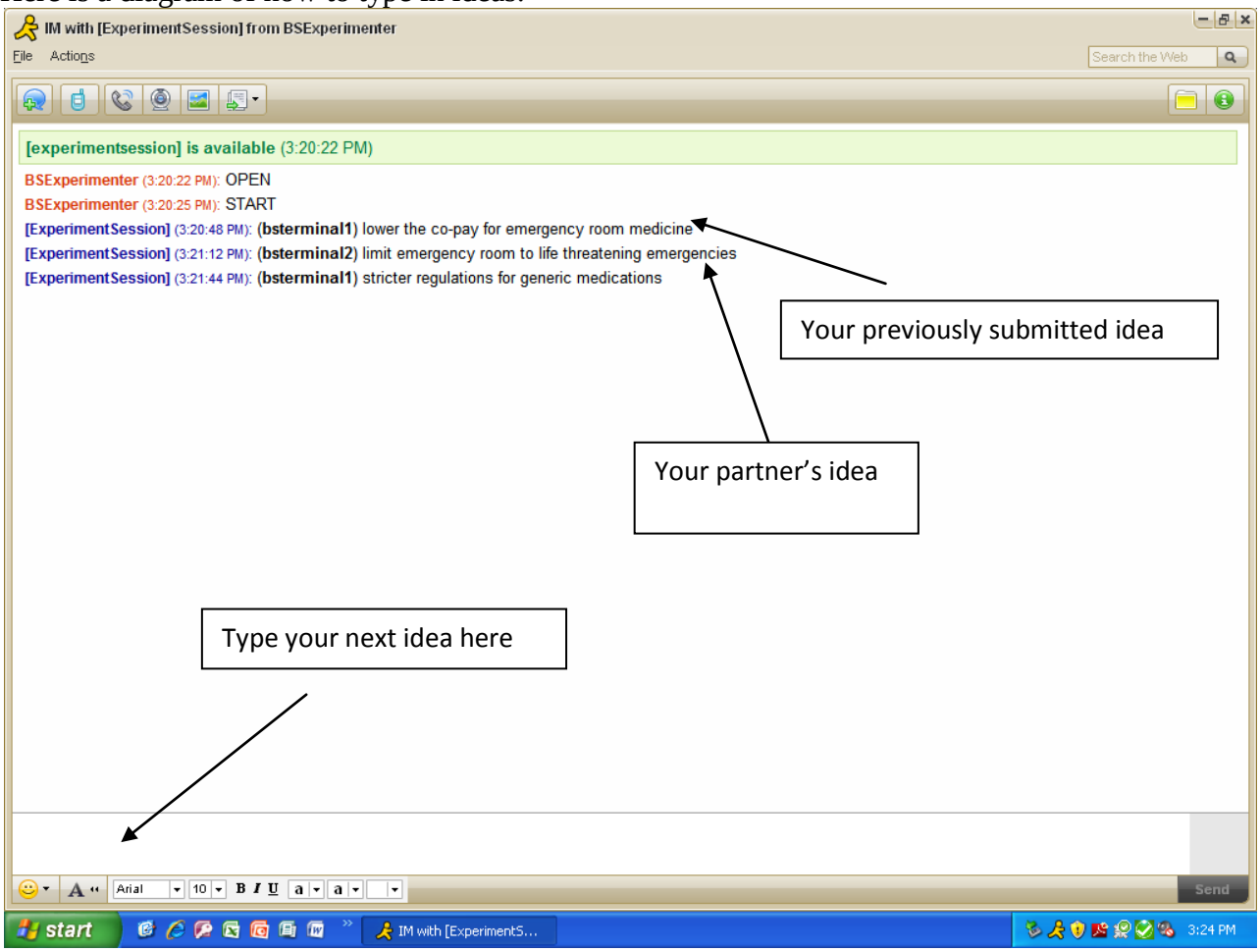


Experiment Instructions (Dyad-No Review)

You are about to participate in an experiment examining idea generation. In a minute you will be given a topic. Your job is to list as many ideas as possible for this topic. These ideas can be as short as a few words. You will submit your ideas by typing the idea into the program (AOL Instant Messenger – "AIM") and then pressing enter. Do not worry about perfect spelling or grammar.

You will be working with your partner on this idea generation task. Each idea you submit will be sent to the other participant as well as the Experimenter. However, the Experimenter will not communicate with you via AIM, except to tell you to "Start" and "Stop."

Here is a diagram of how to type in ideas:

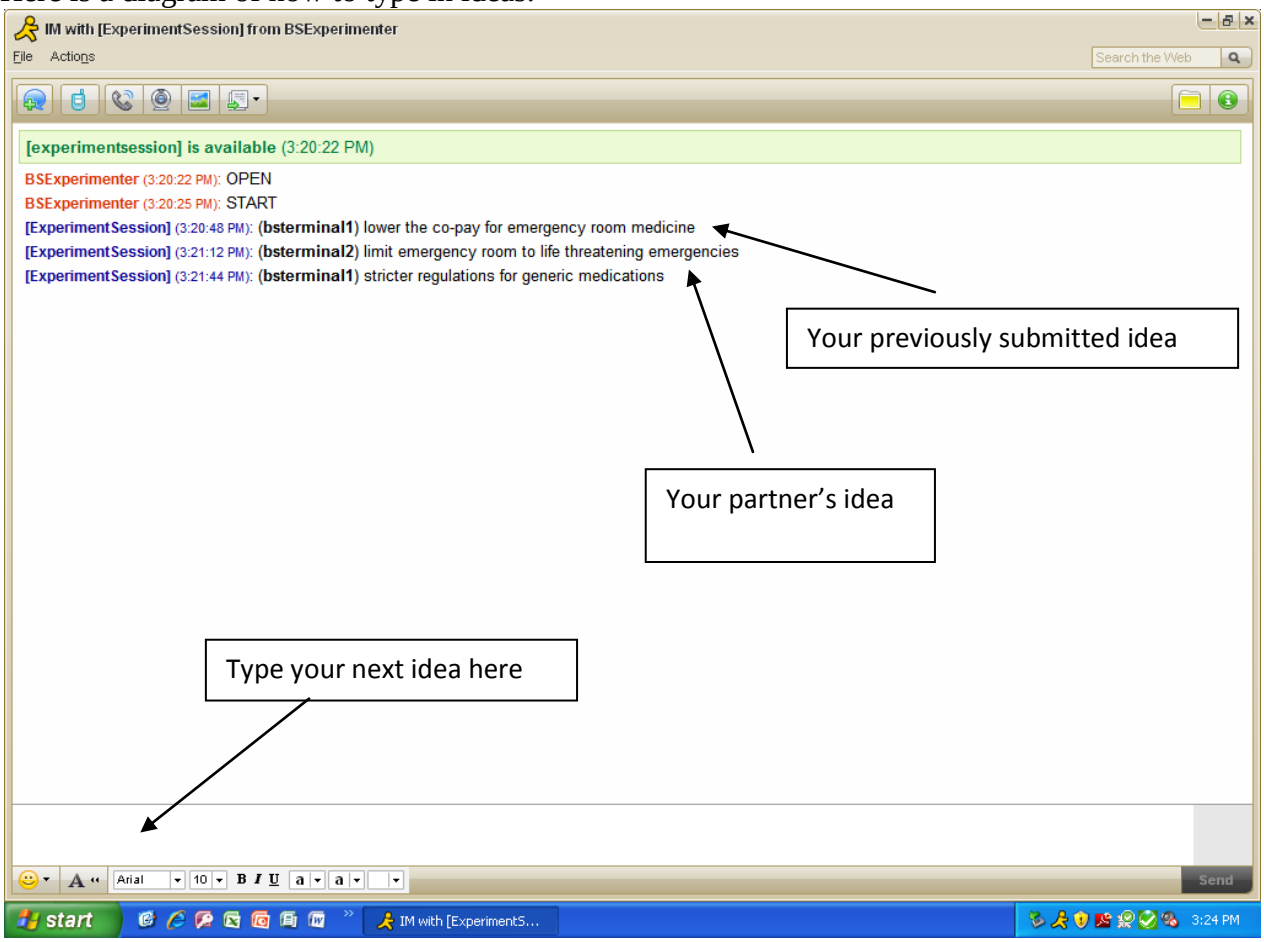


Experiment Instructions (Dyad-Review/Dyad-Old)

You are about to participate in an experiment examining idea generation. In a minute you will be given a topic. Your job is to list as many ideas as possible for this topic. These ideas can be as short as a few words. You will submit your ideas by typing the idea into the program (AOL Instant Messenger – "AIM") and then pressing enter. Do not worry about perfect spelling or grammar.

You will be working with your partner on this idea generation task. You will be periodically allotted time to review each other's ideas. Each idea you submit will be sent to the other participant as well as the Experimenter. However, the Experimenter will not communicate with you via AIM, except to tell you to "Start" and "Stop."

Here is a diagram of how to type in ideas:

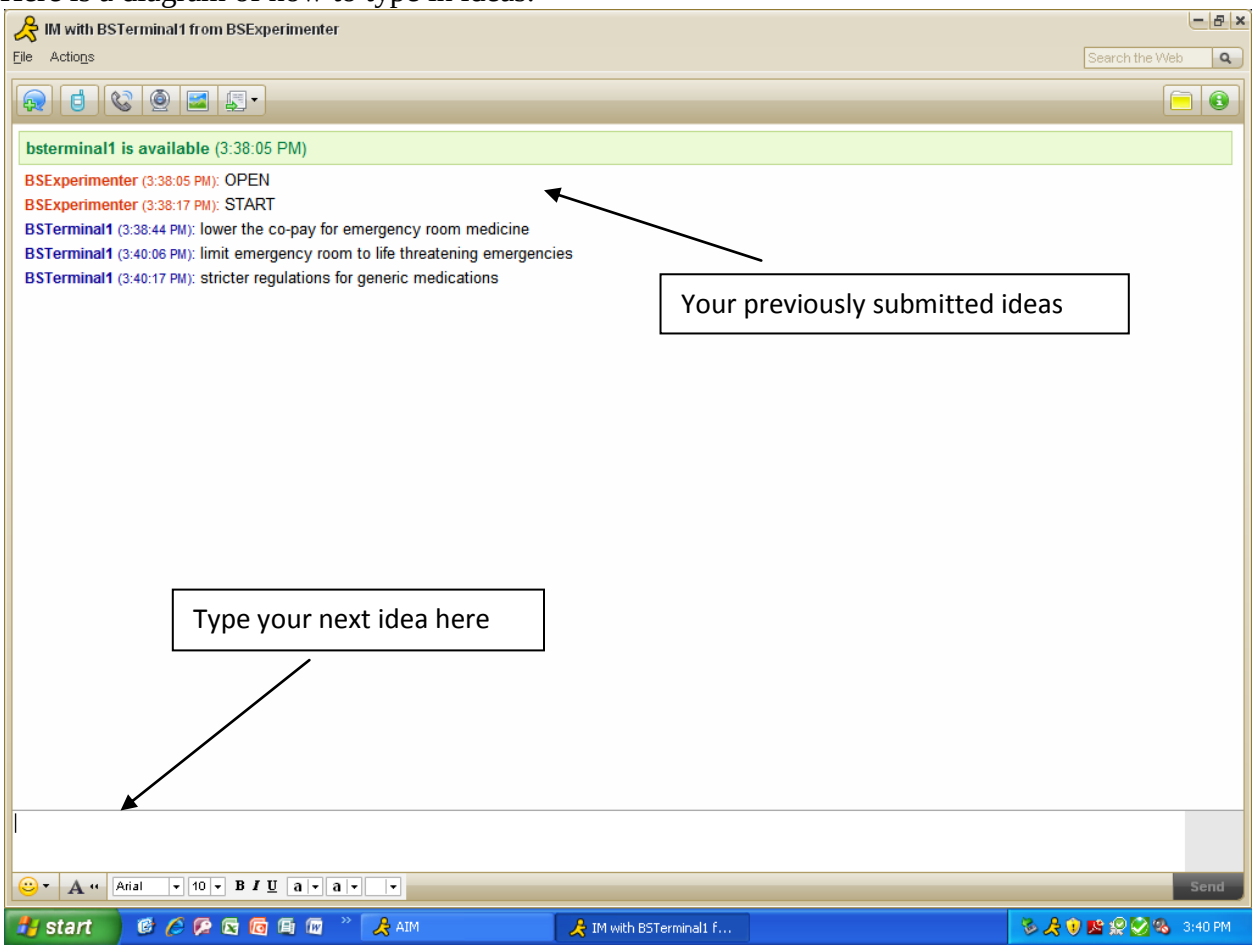


Experiment Instructions (Alone-Review/Alone-New)

You are about to participate in an experiment examining idea generation. In a minute you will be given a topic. Your job is to list as many ideas as possible for this topic. These ideas can be as short as a few words. You will submit your ideas by typing the idea into the program (AOL Instant Messenger – "AIM") and then pressing enter. Do not worry about perfect spelling or grammar.

You will be working with your partner on this idea generation task. You will be periodically allowed to view each other's ideas. Each idea you submit will be sent to the Experimenter. However, the Experimenter will not communicate with you via AIM except to tell you to "Start" and "Stop."

Here is a diagram of how to type in ideas:

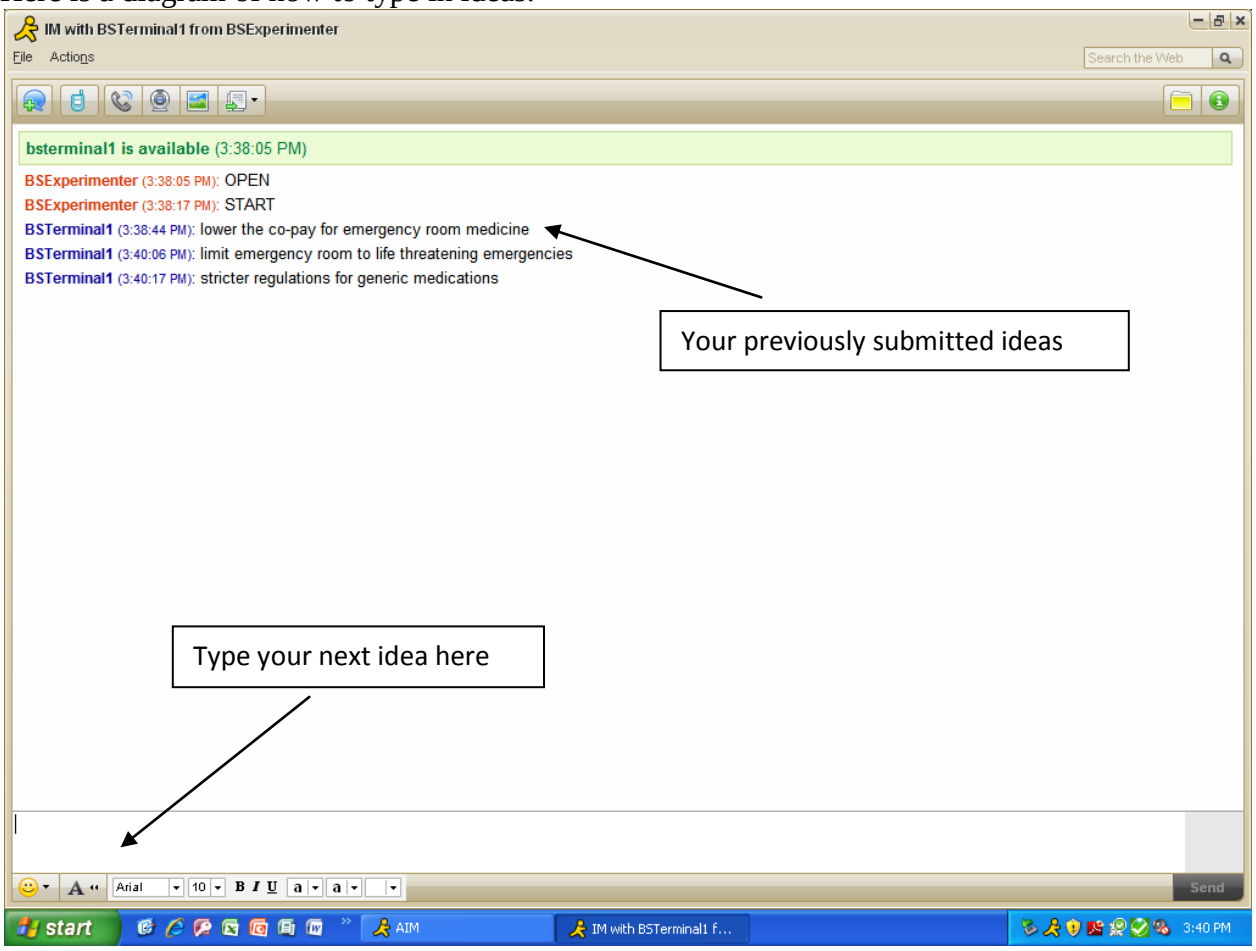


Experiment Instructions (Alone-Old)

You are about to participate in an experiment examining idea generation. In a minute you will be given a topic. Your job is to list as many ideas as possible for this topic. These ideas can be as short as a few words. You will submit your ideas by typing the idea into the program (AOL Instant Messenger – "AIM") and then pressing enter. Do not worry about perfect spelling or grammar.

You will be working alone on this idea generation task. You will be periodically allowed to review your ideas. Each idea you submit will be sent to the Experimenter. However, the Experimenter will not communicate with you via AIM except to tell you to "Start" and "Stop."

Here is a diagram of how to type in ideas:

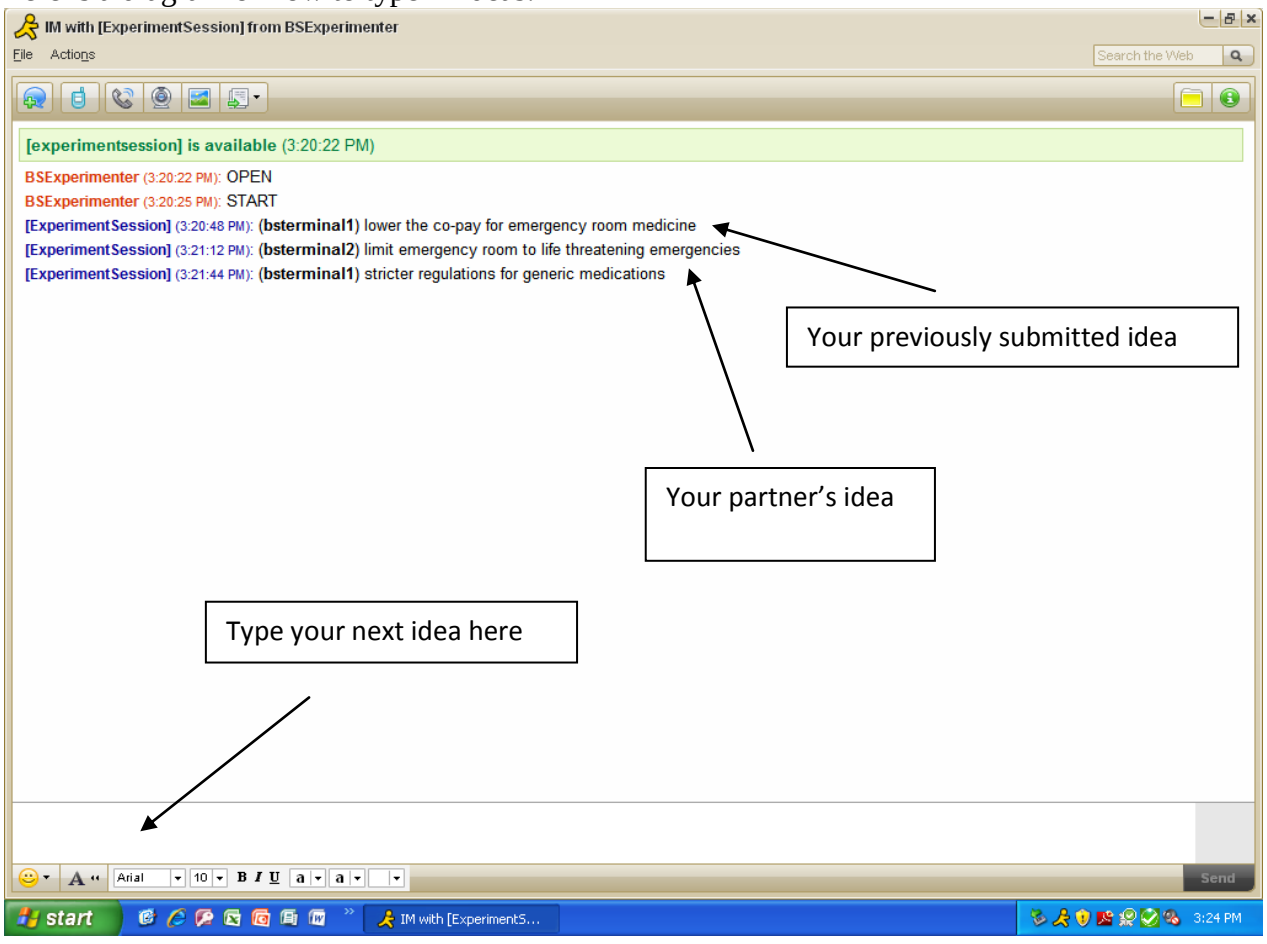


Experiment Instructions (Dyad-New)

You are about to participate in an experiment examining idea generation. In a minute you will be given a topic. Your job is to list as many ideas as possible for this topic. These ideas can be as short as a few words. You will submit your ideas by typing the idea into the program (AOL Instant Messenger – "AIM") and then pressing enter. Do not worry about perfect spelling or grammar.

You will be working with your partner on this idea generation task. Your partner's ideas will be visible to you when you are typing your ideas. Each idea you submit will be sent to the other participant as well as the Experimenter. However, the Experimenter will not communicate with you via AIM, except to tell you to "Start" and "Stop." Additionally, you will be periodically allotted time to review ideas generated by another group.

Here is a diagram of how to type in ideas:



Additional Brainstorming Instruction (All Conditions)

When listing ideas to the brainstorming topic, there are some things we want you to keep in mind:

1) **Criticism is ruled out**. Adverse judgment of ideas must be withheld. Say everything you think of.

2) **Freewheeling is welcome**. The wilder the idea the better. It is easier to tame down than to think up. Do not be afraid to say anything that comes to mind. The further out the idea the better. This will stimulate more and better ideas.

3) **Quantity is wanted**. The greater the number of ideas the more likelihood of good ideas. Come up with as many as you can.

4) **Stay focused on the task**. Concentrate on the problem at hand and avoid engaging in irrelevant thought processes and discussions.
   i. Do not tell stories. We are only interested in your ideas. Do not tell stories about your experiences.
   ii. Do not explain ideas. Do not expand ideas on why you think something is good or bad. Simply state your idea and continue with next ideas.

APPENDIX B

QUESTIONNAIRES

Date: _____ Age: _____
Time: _____ Gender: _____
SS #: _____ Alone-No Review

Questionnaire

How much effort did you expend during the task?

1 2 3 4 5
Not much *A lot*

How important was it for you to perform well?

1 2 3 4 5
Not at all *Very important*

How much pressure did you feel to perform well?

1 2 3 4 5
Not much *A lot*

How motivated were you during the brainstorming task?

1 2 3 4 5
Not at all *Very motivated*

Date: _____ Age: _____
Time: _____ Gender: _____
SS #: _____ Dyad-No Review

Questionnaire

How competitive were you in doing the brainstorming task?

1 2 3 4 5
Not at all *Very competitive*

How much effort did you expend?

1 2 3 4 5
Not much *A lot*

How important was it for you to perform well?

1 2 3 4 5
Not at all *Very important*

How much pressure did you feel to perform well?

1 2 3 4 5
Not much *A lot*

How motivated were you during the brainstorming task?

1 2 3 4 5
Not at all *Very motivated*

How much attention did you pay to your partner's ideas during the brainstorming session?

1 2 3 4 5
Not at all *A lot*

How difficult was it to pay attention to your partner's ideas during the brainstorming session?

1 2 3 4 5
Not at all *Very difficult*

How distracted were you by your partner's ideas during the brainstorming session?

1 2 3 4 5
Not at all *Very distracted*

Seeing your partner's ideas while you were brainstorming helped you generate more ideas

1 2 3 4 5
Not at all *A lot*

Date: _____ Age: _____
Time: _____ Gender: _____
SS #: _____ Dyad-Review/Dyad-Old

Questionnaire

How competitive were you in doing the brainstorming task?

1 2 3 4 5
Not at all *Very competitive*

How much effort did you expend?

1 2 3 4 5
Not much *A lot*

How important was it for you to perform well?

1 2 3 4 5
Not at all *Very important*

How much pressure did you feel to perform well?

1 2 3 4 5
Not much *A lot*

How motivated were you during the brainstorming task?

1 2 3 4 5
Not at all *Very motivated*

How much attention did you pay to your partner's ideas during the brainstorming session?

1 2 3 4 5
Not at all *A lot*

How difficult was it to pay attention to your partner's ideas during the brainstorming session?

1 2 3 4 5
Not at all *Very difficult*

How distracted were you by your partner's ideas during the brainstorming session?

1 2 3 4 5

Not at all *Very distracted*

Seeing your partner's ideas while you were brainstorming helped you generate more ideas

1 2 3 4 5
Not at all *A lot*

How carefully did you read your partner's ideas during the review session?

1 2 3 4 5
Not at all *Very carefully*

Reviewing your partner's ideas helped you generate more ideas.

1 2 3 4 5
Not at all *A lot*

Date: _____ Age: _____
Time: _____ Gender: _____
SS #: _____ Alone-Review/Alone-New

Questionnaire

How competitive were you in doing the brainstorming task?

1 2 3 4 5
Not at all *Very competitive*

How much effort did you expend?

1 2 3 4 5
Not much *A lot*

How important was it for you to perform well?

1 2 3 4 5
Not at all *Very important*

How much pressure did you feel to perform well?

1 2 3 4 5
Not much *A lot*

How motivated were you during the brainstorming task?

1 2 3 4 5
Not at all *Very motivated*

How carefully did you read your partner's ideas during the review session?

1 2 3 4 5
Not at all *Very carefully*

Reviewing your partner's ideas helped you generate more ideas.

1 2 3 4 5
Not at all *A lot*

Date: _____ Age: _____
Time: _____ Gender: _____
SS #: _____ Alone-Old

Questionnaire

How much effort did you expend?

1 2 3 4 5
Not much *A lot*

How important was it for you to perform well?

1 2 3 4 5
Not at all *Very important*

How much pressure did you feel to perform well?

1 2 3 4 5
Not much *A lot*

How motivated were you during the brainstorming task?

1 2 3 4 5
Not at all *Very motivated*

How carefully did you read your own ideas during the review session?

1 2 3 4 5
Not at all *Very carefully*

Reviewing your own ideas helped you generate more ideas.

1 2 3 4 5
Not at all *A lot*

Date: _____ Age: _____
Time: _____ Gender: _____
SS #: _____ Dyad-New

Questionnaire

How competitive were you in doing the brainstorming task?

1 2 3 4 5
Not at all *Very competitive*

How much effort did you expend?

1 2 3 4 5
Not much *A lot*

How important was it for you to perform well?

1 2 3 4 5
Not at all *Very important*

How much pressure did you feel to perform well?

1 2 3 4 5
Not much *A lot*

How motivated were you during the brainstorming task?

1 2 3 4 5
Not at all *Very motivated*

How much attention did you pay to your partner's ideas during the brainstorming session?

1 2 3 4 5
Not at all *A lot*

How difficult was it to pay attention to your partner's ideas during the brainstorming session?

1 2 3 4 5
Not at all *Very difficult*

How distracted were you by your partner's ideas during the brainstorming session?

1	2	3	4	5
Not at all				*Very distracted*

Seeing your partner's ideas while you were brainstorming helped you generate more ideas

1	2	3	4	5
Not at all				*A lot*

How carefully did you read the other group's ideas during the review session?

1	2	3	4	5
Not at all				*Very carefully*

Reading the other group's ideas helped you generate more ideas.

1	2	3	4	5
Not at all				*A lot*

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BIOGRAPHICAL INFORMATION

The author is currently pursuing a Doctoral degree in Experimental Psychology and is a Graduate Research Assistant for Dr. Paul B. Paulus since 2009. She is currently researching group brainstorming and how different techniques can be applied to eradicate the productivity block that groups generally experience. She has a Bachelors of Arts degree in Psychology and a Master of Arts degree in Applied Psychology, both from the University of Mumbai, India. She has been working on several different projects with Dr. Paul B. Paulus such as the studies that have been mentioned in this paper as well as other studies related to electronic brainstorming and creativity.